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December 2007

Strengthening Agricultural Education and Training in Sub-Saharan Africa from an Innovation Systems Perspective

Case Studies of Ethiopia and Mozambique

Kristin Davis
Javier Ekboir
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International Service for National Agricultural Research Division

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Contents

List of Tables

List of Figures

ABSTRACT

This paper examines the role of postsecondary agricultural education and training (AET) in Sub-Saharan Africa in the context of the region's agricultural innovation systems. Specifically, the paper looks at how AET in Sub-Saharan Africa can contribute to agricultural development by strengthening innovative capabilities, or the ability to introduce new products and processes that are socially or economically relevant to smallholder farmers and other agents in the agricultural sector.

Using AET in Ethiopia and Mozambique as case studies, the paper argues that while AET is conventionally viewed in terms of its role in building human and scientific capital, it also has a vital role to play in building the capacity of organizations and individuals to transmit and adapt new applications of existing information, new products and processes, and new organizational cultures and behaviors. The paper emphasizes the importance of improving AET systems by strengthening the innovative capabilities of AET organizations and professionals; changing organizational cultures, behaviors, and incentives; and building innovation networks and linkages.

The paper draws on two main sources of information: the emerging literature on innovation systems in developing-country agriculture, and data gathered from secondary sources and semi-structured key informant interviews conducted in Ethiopia and Mozambique in late 2006.

The paper offers several recommendations that can contribute to enhancing the effectiveness of AET's contribution to agricultural innovation and development. Key reforms include aligning the mandates of AET organizations with national development aspirations by promoting new educational programs that are more strategically attuned to the different needs of society; inducing change in the cultures of AET organizations through the introduction of educational programs and linkages beyond the formal AET system; and strengthening individual and organizational capacity by improving incentives to forge stronger linkages between AET and diverse user communities, knowledge sources, and private industry.

Keywords: Agricultural education and training, innovation systems, Sub-Saharan Africa, Ethiopia, Mozambique

1. INTRODUCTION[1]

Innovation is about doing something "new" by using existing or novel information in new ways. This paper examines how postsecondary agricultural education and training (AET) in Sub-Saharan Africa can contribute to agriculture and rural development by strengthening the capacity to innovate—to introduce new products and processes that are socially or economically relevant to smallholder farmers and other agents in the agricultural sector.

While there is little disagreement over AET's importance to development in Sub-Saharan Africa, there is limited discussion on how new or different approaches to AET might strengthen its contribution. Many of the conventional AET approaches common in the region are designed to build the stock of human and scientific capital through technical training. However, these approaches are often limited in that they are based on a narrow interpretation of the skills and expertise needed to promote development; reliant primarily on formal and inflexible public sector institutions and programs; and only weakly engaged with other economic sectors and knowledge sources.

More innovative approaches argue that AET also has a wider role to play in building the capacity of organizations and individuals to transmit and adapt new applications of existing information, new products and processes, and new organizational cultures and behaviors. However, more analysis is needed on how alternative strategies and selective approaches might shift AET into this role and, ultimately, into closer, more productive relationships with other actors in the agricultural sector and wider economy that build on the comparative advantages of different actors to reduce transaction costs, achieve economies of scale and scope, exploit complementarities, and realize synergies in innovation.

This paper attempts to fill this gap by examining alternative approaches to strengthening the innovative capabilities of AET organizations and professionals; changing organizational cultures, behaviors, and incentives; and building innovation networks and linkages. The paper also examines the role of AET within the wider context of an agricultural innovation system. This innovation systems perspective offers a broad analytical framework with which to examine technological change in agriculture as a complex process of interactions among diverse actors engaged in generating, exchanging, and using knowledge, and conditioned by complex social and economic institutions.

Using AET in Ethiopia and Mozambique as case studies, the paper offers several recommendations for consideration by policymakers working to enhance the effectiveness of AET for agricultural innovation and development. Key reforms include aligning the mandates of AET

[1] The authors thank Etenesh Yitna, Martha Negash, Elizabeth Carbone, and Gwendolyn Stansbury for their technical and editorial assistance; and Bill Saint, Suresh Babu, and five anonymous reviewers for their comments on previous versions of this study. Any and all errors are the sole responsibility of the authors. This study was conducted with funding from the World Bank.

organizations with national development aspirations by promoting new educational programs that are more strategically attuned to the different needs of society; inducing change in the cultures of AET organizations through the introduction of educational programs and linkages beyond the formal AET system; and enhancing individual and organizational innovative capacity by improving incentives to forge stronger linkages between AET and diverse user communities, knowledge sources, and private industry.

It should be noted that in taking an innovation systems perspective on AET, this paper is not a conventional study of the economic trade-offs or rates of return to education. Rather, it is an exploration of a nascent literature applied to the study of developing-country agriculture and, as such, attempts to provide several new ideas and insights on a subject of considerable importance to Sub-Saharan Africa. To do so, the paper draws on two main sources of information: the emerging literature on innovation systems in developing-country agriculture, and data gathered from secondary sources and semi-structured key informant interviews conducted in Ethiopia and Mozambique in late 2006.[2]

The paper is organized as follows. Section 2 provides background information on AET in Sub-Saharan Africa and is followed in Section 3 by a conceptual framework that describes the role of AET within a system of innovation. Section 4 applies this conceptual framework to an analysis of AET in Ethiopia and Mozambique. Section 5 sets forth recommendations for strengthening AET in the context of a developing agricultural innovation system, followed by concluding remarks in Section 6.

[2] See Appendix A for a list of interview subjects and Appendix B for the survey questions used to guide the semi structured interviews.

2. AET IN SUB-SAHARAN AFRICA

2.1. The Current Status of AET in Sub-Saharan Africa

AET systems in Sub-Saharan Africa are commonly structured around at least four different components at the postsecondary level: universities, colleges, technical/vocational schools, and nonformal educational organizations and activities. Each of these components has a role to play in fostering agricultural innovation, a role that depends on the strengths of the specific countries and sectors that it serves.

Formal AET in many African countries can be traced back to colonial systems that emphasized formal education through a small number of elite universities and colleges (such as Fourah Bay College in Sierra Leone, Ibadan University in Nigeria, and Makerere University in Uganda). These institutions were primarily designed to increase the stock of professionals and civil servants needed for colonial administrative systems and, later, to build independent nations (Clark 2006).

Different colonial regimes left behind different educational approaches, especially with respect to agricultural education and research. In much of francophone Africa, colonial approaches did not change significantly with the coming of independence; education in the region has continued to focus on teaching through elite "Grandes Ecoles" (Michelson and Hartwich 2004). However, postcolonial anglophone Africa has witnessed several significant changes. First, many of these countries have introduced a more extensive research mandate into tertiary education (Michelson and Hartwich 2004). Second, many countries have linked their university research programs in agriculture to agricultural research and extension organizations, a structure reflecting the influence of the United States' model of land-grant universities and colleges (Lele and Coffman 1995).

Yet, as will be detailed throughout this paper, while many postcolonial African countries borrowed AET models or structures from Western systems, few have borrowed Western approaches to building innovative capabilities and innovation responsiveness into these systems. By and large, many AET organizations in Africa have changed little since their inception and remain averse to change. What reforms have been undertaken are either in response to government demands for larger numbers of trained professionals or are driven by the availability of short-term and often volatile donor funding. The result is that AET in Africa has not been able to adequately replicate the explicit mandate and functions of similar AET systems in other countries: (a) to educate and produce technically and professionally qualified human resources, (b) to conduct research and produce applied knowledge and technologies, and (c) to disseminate research results while conducting other outreach functions (Clark 2006; InterAcademy Council 2004; Kroma 2003; Alex and Byerlee 1999).

The ability of AET in Africa to meet these objectives is constrained by factors such as recurrent resource scarcities that impede teaching and research; inadequate physical infrastructure, materials,

equipment, and communications facilities; limited teaching and research capabilities, often because the faculty are relatively young and recent graduates of the same institutions or systems; poor incentives for teaching and research in terms of salaries, benefits, and research support services; and limited or volatile funding from a small pool of resources (Clark 2006; InterAcademy Council 2004; Kroma 2003; Alex and Byerlee 1999).

These basic problems are exacerbated by several key issues. First, teaching and research approaches remain organized along a linear vision of science—a vision that subdivides faculties into strict disciplinary departments, provides minimal incentives for understanding the wider demand for scientific applications, gives the greatest importance to theoretical research, and discourages interactions with innovative actors outside academia. Second, many African AET organizations and individuals operate in isolation, with little mobility across organizations and insufficient formal or informal linkages to other organizations with similar or complementary mandates, including local and foreign educational institutions, government ministries and agencies, or national and international agricultural research organizations. Third, many AET organizations are forced to contend with undue interference in the determination of visions, mandates, priorities, curricula, research agendas, and operations due to the strong influence of several dominant suppliers of funding such as government ministries and donor agencies (Vandenbosch 2006; Clark 2006; Eicher 2006; InterAcademy Council 2004; Michelsen and Hartwich 2004; Michelsen et al. 2003; Idabacha 2003; Kroma 2003; Alex and Byerlee 1999).

2.2. The Need to Realign AET in Sub-Saharan Africa

It is thus not surprising that there is an ever-increasing call for sustainable reforms in AET in Africa that respond to changing sociopolitical, economic, and ecological conditions. Most of the reform agenda revolves around university visions and mandates, relevance to national development priorities, changes in curricula, improvements in incentive systems for researchers, alternative financing strategies and organizational structures, and realization of new opportunities in science and technology (African Union 2007; Juma 2005; InterAcademy Council 2004; Idabacha 2003).

The 2003 Jinja Consensus, for example, calls for the creation of a new African agricultural university to build a new cadre of agricultural graduates who will go on to become entrepreneurs and wealth creators rather than cogs in the wheels of existing agricultural education, research, and extension organizations. Ideally, the university would rely on student-centered learning styles in which instructors would facilitate rather than direct the learning process. These graduates would be armed not only with market-oriented skills, but also with a new standard of morals, ethics, and awareness (Idabacha 2003; Wingert 2002).

Reform calls such as this seek a realignment of visions and mandates in AET systems, changes in the cultures of AET organizations, and enhanced innovative capabilities among AET professionals and practitioners. Indeed, these reform calls are consistent with proven successes in AET system development in South Korea during the early decades of its industrialization program (Amsden 1989; Chang 1994).

Thus, Vandenbosch (2006) calls for more relevant and effective AET models that are responsive to changing demands in labor markets (such as combining school-based learning with apprenticeship training) and closer school–community linkages (such as transforming educational institutions into multifunctional community learning centers). He also calls for diversification of funding to increase long-term sustainability, more investment in training and resources for educators, and more effective monitoring and evaluation systems (including action research approaches) to better analyze AET outcomes and achievements.

Eicher (2006) adds to these types of reform recommendations by drawing on experiences beyond Africa to share lessons for improving formal AET in the region. His recommendations include the need to avoid a "one-size-fits-all" approach to system design and structure, and to maintain a long-term, multigenerational time horizon for AET system building. More practically, he identifies a need to mobilize and sustain greater political support for continuous investment in AET, design incentives that attract and retain trained professionals, explore alternative cost-effective training modalities (such as sandwich programs with foreign universities), and invest in graduate (particularly at the M.Sc. level) programs to strengthen AET research.

Rivera (2006) recommends several similar reforms with an emphasis on improving incentives for human capital development and intensifying linkage-building efforts. Specific proposals include extending the region's AET emphasis on formal degree courses to also include greater informal education (in-service, nonformal, and continuing education) for the agricultural workforce at all levels, and integrating AET into a "workforce education system" that brings together both public and private players in a knowledge-support system catalyzed by government incentives to promote greater innovation in agriculture.

These recommendations strongly suggest the need for far-reaching reforms throughout the AET system in Sub-Saharan Africa—from vision and mandate to functions and operations. Consequently, there have been moves to establish new universities in the region and new programs to support such universities (InterAcademy Council 2004; Idabacha 2003).

One such move revolves around the notion of regional "centers of excellence" for Africa. Examples include experiments such as the University of Nairobi's M.Sc. program in agricultural economics, which was established in 1974 and eventually discontinued in 1999 due to a lack of local political and financial support (InterAcademy Council 2004; Oniangio and Eicher 1998); the

establishment of a high-quality Ph.D. program in plant breeding at the University of KwaZulu-Natal; the Africa Union's US$3 billion plan for building excellence in African institutes of science and technology over the next 10 years; and Nigeria's US$25 initiative to establish Africa's premier Institute of Science and Technology in 2007 (Malakata 2007; African Union 2007; Dickson 2006).[3]

2.3. New Ideas About Learning, Innovation, and Agriculture

It is one thing to commit resources, however, and another to build and sustain such systems. To be sure, these recent reform initiatives demonstrate that a more nuanced understanding is needed of AET's role in promoting innovation, development, and growth in agriculture. Greater understanding is specifically needed of how alternative strategies and selective approaches might shift AET into closer, more productive relationships with other actors in the agricultural sector and wider economy, thereby building on the comparative advantages of different actors and institutions to reduce transaction costs, achieve economies of scale and scope, exploit complementarities, and realize synergies in innovation.

This is where an innovation systems perspective might be helpful in understanding just how to reform AET in Africa more effectively. The innovation systems perspective contends that there are multiple sources and users of innovation, AET being just one of them. An AET system thus need not take upon itself the monopoly role of being the "national innovator." Rather, it can assume a role as one among many in enhancing innovative capabilities and responsiveness to innovation opportunities by working more collaboratively and strategically with other actors involved in the wider innovation system.[4]

The following section builds on this idea, describing how an innovation systems approach might be used to facilitate the reform of an AET system to (a) meet a range of functions, from moving people out of rural poverty to maintaining a competitive edge in modern agriculture; (b) involve a wide range of partners drawn from the public sector, private sector, and civil society; and (c) promote continuous change in response to new users and new opportunities.

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[3] There are lessons to be learned from existing initiatives and models being pursued in other parts of the world. For example, the Escuela de Agricultura de la Región Tropical Húmeda, or EARTH University in Costa Rica, provides agricultural education and training by combining classroom instruction with learning-by-doing activities conducted with farmers and other agricultural sector actors. The model is recognized by some as a viable alternative to traditional AET programs in the region (see Clark 2006).

[4] For a similar study highlighting the role of research within the wider innovation system for developing-country agriculture, see World Bank (2006a).

3. UNDERSTANDING INNOVATION: A CONCEPTUAL FRAMEWORK

Several definitions of the term *innovation* have been proposed in the literature, dating back to the work of Schumpeter ([1934] 1961, 1939; OECD 1999; Fagerberg 2005).[5] In this paper we define an innovation as *anything new that is successfully introduced into an economic or social process*. This broad definition includes new technologies as well as institutional and organizational changes. The key words in this definition are *successfully* and *introduced*. A scientific discovery is not an innovation until it is used by an agent to improve what he or she is doing or to initiate new products or processes. The definition also stresses that an innovation is not just trying something new, but successfully integrating a new idea into a product or process that includes technical, economic, and social components.[6]

Our definition highlights the fact that most innovations start as "creative imitations" of existing goods or processes (Metcalfe 2000; OECD 1999). In other words, most innovations are derived from existing information rather than from new information—they are not new to the world, but may be new to the agents that adopt them (Nelson and Rosenberg 1993). This definition differs from the conventional view that defines innovations as discrete, finished outputs such as new technologies.

This definition also changes the traditional conception of scientific research, education, and extension in developing-country agriculture. The traditional conception is based on what might be called a *linear vision of science* (Table 1). In this framework, knowledge flows from basic scientific research and continues downward to strategic, applied, and adaptive research, followed by technology development, dissemination, and, eventually, adoption. While this framework may describe innovation in sectors such as pharmacology or biotechnology (Mowery and Sampat 2005), it tends to oversimplify the innovation process. Often, technological developments precede scientific understanding of the underlying phenomena (for example, the steam engine and thermodynamics) or occur through the reorganization of known processes without accompanying research (Freeman and Soete 1997; Nelson and Rosenberg 1993).

[5] Other disciplines have defined innovation in different ways; see, for example Shavinina (2003).

[6] Schumpeter (1950) introduced this distinction when he distinguished invention (a new idea) from innovation (implementation of the idea).

Table 1. Innovation as a linear versus complex process: A comparison of key elements

	Linear science perspectives	*Innovation system perspectives*
Objectives	Emphasis on ▪ advanced technology and radical innovations ▪ technological "shocks" that change production modalities	Emphasis on ▪ learning within firms and organizations to innovate ▪ strengthening individual and collective capabilities to innovate ▪ long-term efforts to build holistic innovation systems
Strategy	▪ Supply-driven science and technology ▪ Focus on conventional research continuum: basic, strategic, applied, adaptive research ▪ Hierarchical knowledge dissemination: from education to research to extension to user ▪ Typically embedded knowledge dissemination: in capital goods, production inputs, and technology packages ▪ R&D undertaken by large firms (in industrialized countries) and public institutes (in developing countries) ▪ Typically centralized management of innovation processes	▪ Demand- *and* supply-driven science and technology ▪ Focus on the roles and interactions of diverse agents in society and economy ▪ Focus on complex and dynamic interactions among innovative agents ▪ Network-based knowledge dissemination ▪ Both embedded and disembedded knowledge dissemination: in both tacit and codified forms ▪ Typically decentralized management of innovation processes
Instruments	▪ Direct public financing ▪ Indirect public financing: subsidy programs, incentive schemes ▪ Private investment	▪ Scientific exchanges ▪ Advisory and consultancy services ▪ Stakeholder forums ▪ Participatory research projects ▪ Public–private–civil society partnerships ▪ Competitive grant programs ▪ Advanced market commitments Changes to individual and organizational practices, behaviors, and cultures to ▪ promote labor mobility of educators, researchers, and technicians; and ▪ integrate educators, researchers, and technicians into networks with other innovation agents

Sources: Hall 2006; Vázquez-Barquero 2002; authors.

3.1. Systems of Innovation

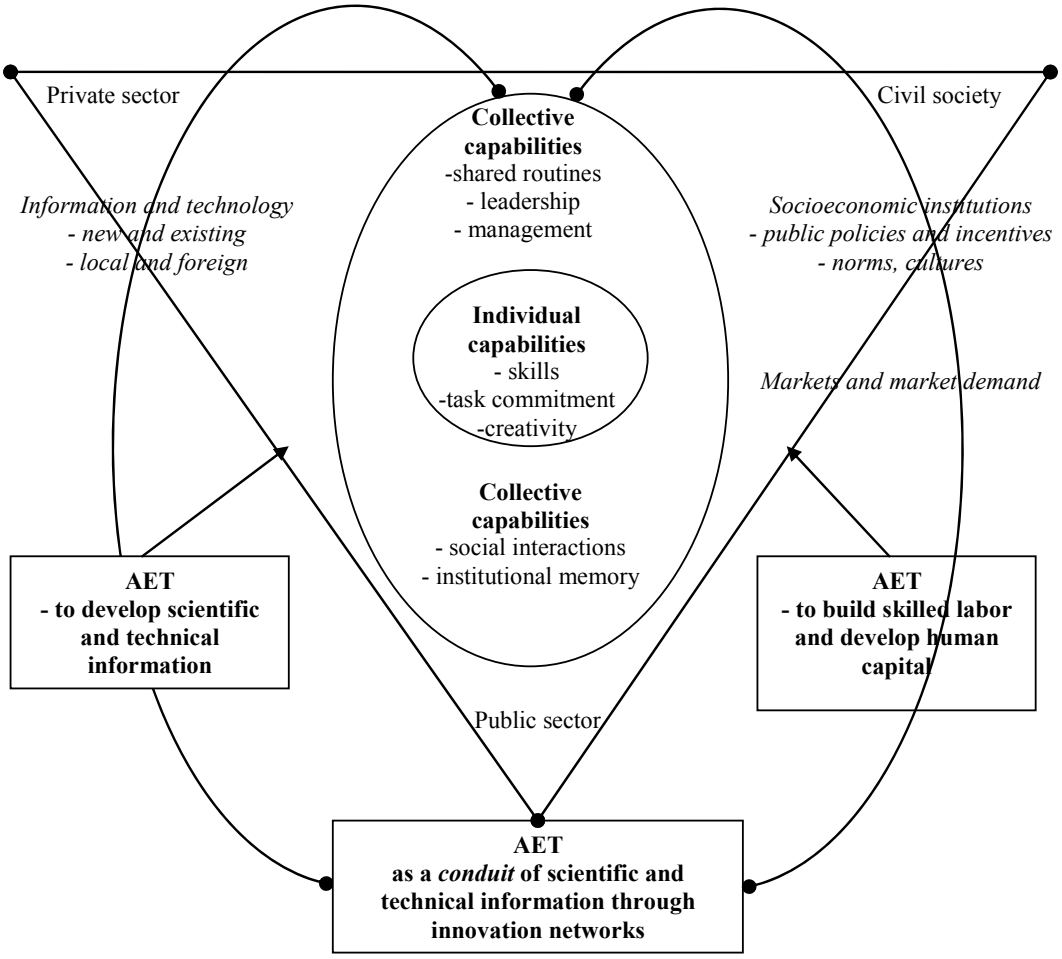
Importantly, this definition of innovation suggests the need for a more nuanced understanding of the innovation process, specifically with respect to developing-country agriculture. Hence, we emphasize here the concept of an *innovation system,* which consists of the agents involved in the innovation process, their actions and interactions, and the formal and informal rules that regulate their practices and behaviors

(Lundvall 1985, 1988; Freeman 1987, 1988; Nelson 1988; Dosi et al. 1988; Edquist 1997). As shown in Figure 1, an innovation system embeds technological change within a larger, more complex system of actions and interactions among diverse actors, social and economic institutions, and organizational cultures and practices.

An important implication of the innovation systems approach is that innovations emerge spontaneously from the interactions of different types of agents; their existence does not necessarily depend on any government action, although these actions can have great influence on their evolution and strength. Hence, an innovation system is larger than the national research system (NRS) and larger than the set of public sector organizations charged with the creation and dissemination of new technologies. In other words, there are multiple sources of innovation.

A country's innovation system can be strong even when its NRS is weak. Ecuador and many Central American countries, for example, have had weak NRSs and strong innovation systems that have allowed them to develop strong competitive clusters in fresh fruits and vegetables. In contrast, the Soviet Union of the 1970s had a strong research system and a weak innovation system.

Figure 1. **AET in a system of innovation**



The innovation systems approach offers useful insights into the conception of AET for agricultural sector development, including the following:

- New inputs or technologies should not be viewed as innovations themselves, but as *embedded information* that agents can use in different ways, including ways that are different from what they were created for (Metcalfe 2000).
- Innovations depend on the ability of agents to *learn*—on their ability to gather information and use it creatively in response to market opportunities or other social needs (Lundvall 1999; OECD 1999).[7]
- Learning depends on the ability of agents to *interact and exchange* information and knowledge. Interactions can occur at any stage in the processes of producing, exchanging, or applying knowledge (Fagerberg 2005; Nelson and Rosenberg 1993).
- Innovation is constrained by *complexity*. Complexity in process, product, equipment, and instrumentation means that individual agents may not have all the resources they need to innovate fast enough to remain effective or competitive (Powell and Grodal 2005; Rycroft and Kash 1999).
- Successful innovation systems *balance* the search for existing information with the creation of original information, a balance that should change according to the strength of the networks within which agents interact, and their individual and collective capabilities (Renzulli 2003; Rycroft and Kash 1999).
- The economic or social performance of a country depends on the *participation* of many innovative agents that foster the emergence of an innovation system. Particularly important to this notion is the emergence of effective interactions between a country's scientific base and its business community (Powell and Grodal 2005; OECD 1999; Rycroft and Kash 1999; Nelson and Rosenberg 1993).
- The economic or social performance of a country also depends on the set of *enabling* conditions—market infrastructure, appropriate property rights, and effective governance in both input and output markets—that foster the emergence of innovative agents (Powell and Grodal 2005; Nelson and Rosenberg 1993; OECD 1999; Rycroft and Kash 1999).

These insights mean that a successful innovation system depends on several key elements: the idiosyncratic characteristics of the information, the capacity of individuals and organizations to learn and

[7] The most recent literature on innovation systems recognizes the central role of learning in generating innovative capabilities, to the point that Edquist (2005recently proposed replacing the concept of *innovation system* with that of *learning systems*.

innovate, the nature and character of interactions among innovation agents, and the formal and informal institutions that regulate the agents' interactions.

In the following subsections, we focus on three of these elements: individual and collective innovative capabilities, organizational cultures and behaviors, and networks and linkages among innovation agents. This focus may provide a better understanding of why an innovation systems perspective can be helpful in designing and implementing AET system reforms—reforms that help an AET system undertake a range of functions, involve a wide range of partners, and change in response to new users and new opportunities, ultimately contributing to growth and development.[8]

3.2. Individual and Collective Innovative Capabilities

The use of individual and organizational (collective) capacities to innovate—specifically, to identify and use existing information to create something new—is a central concept to the study of innovation systems. Here, we refer to these qualities as innovative capabilities (Cohen and Levinthal 1990). A starting point for reforming AET systems in Africa might be to first consider how to build innovative capabilities that help AET meet a range of functions, involve a wide range of partners, and continuously evolve in response to new users and opportunities. It is within this context that we explore the role of individual and collective capabilities in detail below.

Individual Innovative Capabilities

Almost every person is born with the basic physiological apparatus to innovate (Vandervert 2003). Individual capabilities depend on how an individual sees, understands, and interprets the environment in which he or she is immersed. The cornerstone of individual capabilities to innovate is the originality of the representations an individual creates (Shavinina and Seeratan 2003; Renzulli 2003).

Studies of the nature of innovative capabilities have shown that innovative individuals possess above-average learning abilities (but not necessarily exceptional abilities), show strong task commitment, and are creative (Shavinina and Seeratan 2003; Renzulli 2003). The talent for innovation results from the interactions among these three factors, and not from being exceptional at one or two. Other factors that influence innovative capabilities are personality and the environment, including aspects such culture and gender (Georgsdottir, Lubart, and Getz 2003).

This suggests that some people (but not all people) are innovative on certain occasions (but not all occasions), at certain moments (but not all the time), in certain environments, and in particular areas of

[8] Note, however, that applications of the innovation systems perspective to developing-country agriculture are fairly nascent. For a survey and critique of the innovation systems literature with respect to developing-country agriculture, see Spielman (2006a, 2006b). For a wider discussion of directions in the innovation systems literature, see Balzat and Hanusch (2004).

activity, such as dancing, biology, or business, for example (Renzulli 2003). In other words, innovativeness is dissimilar from a talent for, say, science or acting—talents that are relatively stable through life and can be nurtured through additional training—because innovativeness may come in spells and bouts.

Moreover, innovative capabilities are not necessarily linked to formal education or good grades, but to learning processes (Renzulli 2003). This does not mean that formal education is not important; formal education often has an indirect effect on innovation by enhancing the individual's ability to process information and by increasing his or her specialized knowledge. For example, although taking a course in quantum physics will not make a person innovative, an innovator cannot work on nanotechnologies without knowing quantum physics.

There is much evidence to suggest that innovative capabilities are not reserved to those commonly labeled as innovators, such as scientists, researchers, and entrepreneurs. For example, studies of business and management suggest that users—often termed "lead users"—frequently play a role in the development of new products, and that user needs and requests directly initiate a significant portion of innovative activity in certain industries (Kim and Mauborgne 2001; Ochieng 2007). In the medical equipment industry, Shaw (1985) shows that clinics and doctors have been responsible for 53 percent of new product developments in several medical subareas. In the entertainment, recreation, and food industries, Shah (2000) similarly shows that it was the end users who invented the first versions of basic equipment for a variety of products.

There is also evidence to suggest that the distribution of innovative capabilities among individuals is highly skewed. Even though there are few methods to measure traits such as learning ability, task commitment, and creativity, it is generally accepted that not all individuals possess these traits together (Renzulli 2003). And because innovative capabilities are skewed, it is often difficult to design education and learning systems that are sufficiently responsive to different individuals possessing different combinations of different traits (Reis and Renzulli 2003).

One implication is that educational approaches and learning philosophies applied to AET in Africa need to accommodate different types of individuals. For example, tertiary education systems might consider diversifying away from well-structured degree programs centered solely on traditional disciplines and moving into a wider variety of programs, ranging from short applied courses to short-term professional training to long-term multidisciplinary degree programs.

Another implication of this is that it is not easy to create (or expand) a menu of learning opportunities in an AET system that is appropriate for diverse capabilities. A strategy of building such a menu for AET in Africa requires flexible policies and practices, such as employment regimes where underperforming professionals can be fired and good professionals promoted, and reliance on the

expertise of foreigners only to the extent that they transfer expertise to local instructors.[9] It also requires adjustments in organizational cultures, curricula, and teaching methods to encourage new ways of fostering innovation, as well as investment in programs and partnerships that link the AET system to outside knowledge sources, international educational standards, and new trends in education.

Consider that in the last two decades, innovation systems in industrialized countries have undergone major transformations that have affected the structure and content of postsecondary education (Pavitt 2005). As production processes have become increasingly complex, the demand for an educated workforce with a high degree of specialized knowledge has similarly increased. In turn, this trend has challenged the relevance of the traditional university structures and curricula that are geared to preparing professionals with a general or "encyclopedic" education (Christensen, Anthony, and Roth 2004). The knowledge required by a professional workforce is often highly contextual or tacit—for example, specific management routines used in a firm. This type of knowledge is difficult for universities to obtain and convey to students; it requires educators to continuously update their own knowledge, develop new areas of expertise, and forge linkages with industry and other sectors (see Mowery and Sampat 2005; Mowery and Rosenberg 1993; Chesnais 1993).

Collective Innovative Capabilities

Organizational or collective innovative capabilities reside in individuals (including leaders, managers, and employees); in the information and technology used by an organization; and in an organization's structure, routines, and coordination methods (Argote and Darr 2000). Organizational capabilities result from the interaction among resources (individuals and fixed capital), processes (the "way things are done" in an organization), and values (including organizational cultures and long-term objectives). Organizational capabilities are specific to each organization—they are developed through idiosyncratic investments and processes and cannot be easily copied or bought by other organizations. Organizational capabilities are also contextual—a capability in one context can become a disability in another context. This is why some organizations succeed where others fail (Appelyard, Hatch, and Mowery 2000; Christensen 2003).

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[9] It is argued, in fact, that the slow adaptation of traditional universities to change has opened the door for alternative educational institutions in many industrialized countries: online learning programs offered by for-profit providers (such as the University of Phoenix) that enable working adults to earn a degree in their spare time; corporate universities (such as GE Crotonville, Motorola University, and IBM's management training programs) to teach workers and managers the specific skills they need to solve the problems they face in the workplace; and community colleges that offer a low-cost way for students to become certified in many professions such as nursing and information technology, bypassing more expensive four-year institutions (Christensen, Anthony, and Roth 2004). The growing variation in postsecondary educational options in industrialized countries illustrates one approach to responding to differences in individual absorptive capabilities.

In new organizations, most of these capabilities reside in their resources, especially their people; thus, the introduction or departure of one person can have a big influence on the organization's innovative capabilities. With time, these capabilities are transferred to processes and values in the organization, making it less dependent on single individuals (Christensen and Raynor 2003). These processes and values are consolidated into shared knowledge and accepted routines regarding governance, coordination, and social interactions within the organization and with external actors (Dosi, Nelson, and Winter 2000; Coriat 2000; Zander and Kogut 1995; Bailey and Ford 2003).

The consolidation process also implies that over time, some organizations reduce their capacity to explore new, alternative, or better processes (Bailey and Ford 2003). Without purposely creating new structures, cultures, and knowledge to explore new processes, the organization can become less, rather than more, innovative. Thus, organizations that purposely try to sustain their innovative capabilities do so by investing in learning and by hiring new employees with specific knowledge (Christensen and Raynor 2003).

But building these capabilities is often difficult because they cannot be easily bought, and, even when they are, it is often difficult to integrate them into existing structures. Moreover, it is difficult for organizations to develop their capabilities arbitrarily because these processes are often path dependent. The trajectories not only define the options the organization currently faces, but also set the limits of the options that will appear in the future. For this reason, decisions on which capabilities should be developed in the long term are often costly to reverse, thus suggesting a high degree of path dependency in the decision-making process (Teece, Pisano, and Shuen 1997).

Thus, the efficient development of new capabilities requires a "vision" of the changes to be introduced, a large number of trials to reduce uncertainty, effective feedback loops to evaluate the trials, and debate within the organization to develop a consensus about what is desirable and what is acceptable (Dosi, Nelson, and Winter 2000). The effectiveness of feedback loops and learning mechanisms is crucial because the number of options that can be tried is limited by coordination problems within the organization, by the resources available to explore alternatives, and by the organization's learning capabilities (Christensen and Raynor 2003; Levinthal 2000).

The implication here is that AET systems are, by definition, comprised of organizations with their own innovative capabilities that have developed over time and from context-specific factors. However, such capabilities often develop without sufficient reference to the needs of other actors in the innovation system, or to the possibility that needs change over time. Hence, a strategy to strengthen AET in Africa would not only include a discussion of its role in innovation processes, but also of the strategies required to develop organizational innovative capabilities to understand and pursue this role effectively.

3.3. Organizational Cultures, Behaviors, and Incentives

An organizational culture can be defined as a set of basic assumptions that are invented, discovered, or developed by a group in the process of learning how to deal with external adaptation and internal integration (Schein 1984). The set of assumptions is considered valid by the group if it has worked well enough in the past (by whatever standards the group may choose to assess it). This organizational culture is then taught to or adopted by new members of the group as the correct way of approaching problems in the organization.

In essence, organizational cultures define what an organization can and cannot do. For example, the Xerox laboratory in Palo Alto developed a personal computer in 1973 with a mouse and a graphic interface (later copied by Apple), an operating system that could run several applications simultaneously (the basis for Windows), a word processor (later developed by other software companies), and connectivity capabilities (a forerunner of larger networking systems) (Carayannis, González, and Wetter 2003). But Xerox's culture, centered on photocopiers and mainframe computers, did not allow the management to see the potential of these discoveries.

The above definition stresses that (a) an organizational culture is a set of beliefs, not values or behaviors; (b) it is invented by a group in the early days of the organization and is then passed on to or acquired by newcomers; (c) building the culture takes time because it requires the repeated use of specific approaches to successfully tackle similar problems; and (d) organizational cultures usually change very slowly because beliefs typically change only after they repeatedly fail to deal with new situations and are then rejected by the organization as a whole (Christensen and Raynor 2003).

Organizational cultures can also change suddenly—for instance, when the organization faces a major threat or a massive induction of new members. But even when a large number of people are hired by an organization with the potential to change its stock and distribution of individual capabilities, it is often the case that the newcomers are expected to adapt to the prevailing culture. Only through repeated failures will the organization reexamine the assumptions and form new ones, even though the new assumptions will still be influenced by the ones they replace. In short, the evolution of organizational culture is a path-dependent process.

A number of external and internal factors influence the emergence of an organizational culture. The external factors are related to the perception the founding group has about the environment and about how to survive in it. Internal factors are related to the group's perception about how to organize relations among the organization's members so that the organization can survive while minimizing internal conflicts. The problems of external adaptation are related to the development of a consensus about the organization's mission and objectives and the means to achieve them. The internal factors are related to

the development of common language and concepts, the establishment of the group's frontier—especially the criteria to exclude members—and the definition of power structures and incentives.

Understanding the nature and dynamics of organizational cultures is important to the design and implementation of successful AET reforms. For example, if the culture of a university researcher's academic department is one in which colleagues are—or are expected to be—highly productive, then individual researchers tend to conform to the accepted norm. If output is regarded as less important, then their productivity necessarily conforms to a different norm. Similarly, if the department's culture is one in which colleagues are—or are expected to be—highly interactive with other researchers outside the department, then their networking behaviors will similarly conform.

Implicit in this discussion is the idea that significant change is needed in the cultures and behaviors that characterize AET organizations in Africa. This includes a need to transform the cultures and behaviors of AET systems from those driven by traditional sets of beliefs about what AET can and should do—educating for scientific excellence, for example—into cultures and behaviors that allow for greater innovation—educating to create new applications of existing knowledge and information, products and processes, and organizational structures and management.

3.4. Networks, Partnerships, and Linkages

One way of facilitating greater innovation through AET reforms is to better understand the market for innovation. This means not only understanding the supply of innovation—foreign universities that generate new technologies, foreign consultants that generate new organizational management paradigms, or traditional/indigenous institutions that preserve local knowledge and practices—but also understanding the source of demand for innovation, or the "user community." This community can be classified into four broad categories in Africa; AET's contribution to each is listed accordingly.

1. Small-scale, resource-poor farmers operating with limited market interaction. A large proportion of the rural population in Africa consists of farmers who produce little or no marketable surpluses of food staples from a degraded natural resource base with minimal infrastructural improvements, few modern inputs, and limited market access. Here, AET's contribution might be to strengthen public sector agricultural extension services with individuals trained in the application of modern production inputs and technologies and, ideally, to integrate these inputs and technologies with indigenous knowledge and practices.

2. Small-scale farmers operating in domestic markets. These farmers may use relatively less sophisticated production and processing technologies and marketing techniques than commercial farmers in the high-value export market, but they too require skilled workers to help produce, distribute, and market commodities in the quality and quantity demanded by consumers in growing urban and peri-urban

centers. The AET system's main contribution here might be to strengthen capabilities in areas such as distribution and marketing, business management, and administration. However, there is also a need to strengthen capabilities in managing collective action (such as lobbying and advocacy for policy reforms that support domestic commercial agricultural) and in agroprocessing (such as packaging to meet sanitary and phytosanitary standards).

3. "Transitory" farmers—farmers with the potential to become successful commercial farmers. Although they may be constrained by a lack of information or knowledge, a technological or infrastructural impediment, or risk-averse tendencies, these farmers have the potential to engage in profitable commercial farming. The AET system's main contribution here might be to strengthen entrepreneurial capabilities. This requires the development of public and private providers of business-development services comprised of individuals who are well trained in business and marketing, social organization and collective action, and technology use.

4. Large commercial farm operators in the high-value export sector. These farm operators typically rely on imported production and processing technologies and marketing techniques. Owners and managers may include both domestic and foreign entrepreneurs and companies, while labor supervisors, skilled laborers, and even unskilled laborers may be drawn from domestic sources or from neighboring countries that have previous experience with these types of operations. High-value horticulture in eastern and southern Africa, for example, is increasingly the domain of both domestic and foreign entrepreneurs, as well as joint ventures between the two. These farm operators require qualified skilled workers to operate relatively sophisticated machinery and equipment, apply chemical inputs that require accurate attention to timing and quantity, and understand relatively sophisticated production and processing systems. The AET system's key contribution here is the short-term supply of skilled workers in a quantity that sustains the farm operators' comparative advantage based on cheap production factors. In the medium term, however, such farm operators need AET systems that provide institutional and organizational support on issues such as improving marketing, transportation, and financing that enable them to maintain the comparative advantage. In the long term, as the importation and imitation of foreign technologies gives way to more local processes of adaptation and innovation, such farm operators require AET systems that generate research to address emerging issues such as new biotic and abiotic stresses.

Another way of facilitating greater innovation through AET reforms is to address the fundamental economic constraint underlying innovation—the scarcity of resources with which to innovate. One way of doing so is for agents to integrate into innovation networks to achieve economies of scale and scope, reallocate labor and human capital more efficiently, reduce transactions costs, exploit complementarities, and realize synergies in the innovation process. These networks can vary from informal interactions between extension agents and farmers to promote a new plant variety, to very complex contracts between

public researchers and private firms to conduct research in advanced biotechnology. More than a linear sequence, an innovation process might then resemble a spider web of related individuals and organizations, all of whom contribute something to the application of new or existing information and knowledge. Innovation networks include universities, colleges, technical/vocational centers, farmer organizations, research centers, private firms, nongovernmental organizations (NGOs), farmers, and other actors who create, exchange, or use knowledge and technology.

An important feature of a successful innovation network is that its membership varies in response to changes in the members' vision and goals; to new economic, social, or technological challenges; and to the maturity and complexity of the technology. Thus, simple or mature technologies might be developed by isolated teams of researchers or engineers working under the umbrella of a single organization (such as a university or private laboratory), while new or complex technologies might be developed by networks that include researchers from different public research organizations, private firms, and/or associations representing end users.

Innovation networks critically depend on a diversity of agents. While scientists and educators may play a role in providing new methods, materials, and personnel, actual innovations are often developed and disseminated by nonscientists—engineers, marketing specialists, suppliers, and buyers. This is often true even in science-intensive sectors (such as pharmaceuticals, biotechnology, and nanotechnology), where scientists typically develop only the basic components that are then integrated into marketable products by other individuals (Mowery and Sampat 2005; Malerba 2005).

Another key feature of a successful innovation network is the nature of interactions among its members. Formal and indirect interactions (usually mediated by markets) are more common with simple or mature innovation processes because all agents have a clear idea of the technical standards and the needs of other agents. Informal and direct interactions, in contrast, are more common with more complex or newer technologies where there exists greater uncertainty about technical standards, the innovation's economic potential, and other agents' needs (Rycroft and Kash 1999).

Innovation networks can be limited in terms of effectiveness by any number of organizational or institutional factors: internal structures and administrative cultures that discourage network formation, innovation programs organized along the linear vision of science, intellectual property rights regimes that discourage investment in research and innovation, or long-standing relationships between innovators and end users that limit opportunities to reciprocate in the sharing of knowledge.

The implication for AET in Africa is that networks, partnerships, and other interactions that link a wide range of stakeholders in an agricultural innovation system—and that change over time in response to changing users and opportunities—are essential. This system may include research-driven networks that include university science programs, agricultural research organizations, input suppliers, extension agents,

and farmers and may rely on participatory research programs or other network modalities that encourage innovation through the movement of knowledge and information between and among individuals and organizations.

3.5. AET in the Wider Innovation System

Several principles can be drawn from the innovation systems perspective set forth above and applied to the design and improvement of postsecondary AET in Sub-Saharan Africa. Key principles include the following:

- Innovation goes beyond scientific research and the dissemination of new technologies; the actions and interactions of diverse agents, and the social and economic institutions that condition their practices and behaviors, are of equal importance to understanding the innovation process.
- Innovation depends on the development of individual capabilities. Educational approaches and learning philosophies applied to AET need to cover a wide menu of options that accommodate different types of individuals.
- Innovation depends on the development of organizational capabilities in AET systems with sufficient reference to other innovation system agents and with an eye to ensuring the continuous ability of organizations to change over time in response to new users and opportunities.
- Innovation depends on the development of organizational cultures and behaviors that transform AET systems into conduits for transmitting new applications of existing information, new products and processes, and new organizational cultures and behaviors.
- Innovation depends on the active participation of AET professionals in networks, partnerships, and other interactions that link a wide range of stakeholders in an agricultural innovation system.

With these principles in mind, we move on to an analysis of postsecondary agricultural education and training in Ethiopia and Mozambique from an innovation systems perspective.

4. AET IN ETHIOPIA AND MOZAMBIQUE

This section examines AET systems in Ethiopia and Mozambique in order to identify gaps or weaknesses in their potential contribution to strengthening agricultural innovation and sectoral development.

First, it is worth noting that Ethiopia and Mozambique share several historical, political, and economic similarities that will help illustrate certain commonalities in their AET systems. Both Ethiopia and Mozambique are largely agricultural economies characterized by high rates of poverty and food insecurity (Table 2). Both countries host largely subsistence agriculture sectors characterized by smallholder farming systems, low modern input use, and limited commercialization. Both are "postconflict" countries, having come out of protracted civil strife in the early 1990s. And, since the end of conflict, both have experienced rapid—though often volatile—economic growth and development.

Both countries have invested in building the fundamental structures of an AET system—universities, technical/vocational schools, and in-service training programs—and have complemented them with agricultural research and extension systems. Both countries have also put their AET systems to use in recent years to support agricultural development policies and strategies that focus on boosting agricultural yields and output in order to improve food security and reduce poverty.

However, both countries are also host to fairly weak knowledge economies. According to the Knowledge Economy Index (KEI), both countries have weak national-level abilities to generate, adopt, and disseminate knowledge, at least according to indicators for the four pillars of the knowledge economy: economic incentive and institutional regime, education and human resources, the innovation system, and information and communications technology.[10]

[10] It can be argued, however, that the KEI indicators have significant limitations in contributing to an understanding of innovation in the agricultural sector as they (a) tend to overlook more localized innovation processes that while difficult to capture in national surveys may nonetheless contribute to knowledge economy performance and (b) include many subindicators that might not be immediately relevant to agricultural innovation in a smallholder farming system, such as patent applications or scientific and technical journal articles.

Table 2. Key economic indicators, Ethiopia and Mozambique, c. 2002–04

Indicator	Ethiopia	Mozambique	Sub-Saharan Africa
GDP growth rate (%)[a]	5.2	7.7	3.6
Agricultural GDP (% of GDP)[a]	46	24	18
Rural population (% of total population)[a]	85	67	66
Agricultural population density (persons/ha) [b]	5	3	2
Cereal yield (kg/ha)[a]	1,242	876	1,086
Foreign direct investment (% of GDP)[a]	4	6	3
Cereal exports (in millions of US$)[c]	1.73	0.03	-
Avg. export unit value of cereals (US$/ton)[c]	330	1,000	-
Cereal surplus (exports - imports) (in 1,000 tons)[c]	-52	-4	-
Proportion of undernourished in total population[d]	46	44	33
Poverty (% of population below national poverty line)[e]	44	69	-
Literacy (% of population age 15+)[f]	42	46	65
Gross primary enrollment (% of school-age pop., male/female)[f]	76/55	114/93	102/88
Knowledge Economy Index scores[g]	**Ethiopia**	**Mozambique**	**All Africa**
Economic incentive regime	1.37	2.52	2.57
Innovation	0.61	0.42	3.03
Education	0.81	0.28	1.39
Information and communications technology	0.1	0.93	2.51

[a] 2000–2005 average. Source: WDI 2006.
[b] 2001–2003 average. Source: FAOSTAT 2006.
[c] 2004. Source: FAOSTAT 2006.
[d] 2002–2004 average. Source: FAOSTAT 2006.
[e] 2000 for Ethiopia; 1997 for Mozambique. Source: WDI 2006.
[f] 2002. Source: WDI 2006.
[g] 2004. KEI scores are scaled from 1 (lowest) to 10 (highest). Source: KAM 2006.

Ethiopia is host to some of Africa's oldest institutes of higher learning that focus specifically on the agricultural sciences, including Jimma University and Ambo College of Agriculture (established as junior colleges of agriculture in 1947), and Haramaya University (formerly Alemaya University and founded as the Imperial College of Agricultural and Mechanical Arts in 1953). Today, there are seven institutes of higher learning in the field of agriculture, as well as 25 agricultural technical and vocational education and training (ATVET) colleges throughout the country, all funded and managed by the federal and/or regional governments.[11]

Private university education is also expanding throughout Ethiopia's urban areas, although the emphasis is primarily on business management and administration, information and communications technology, and other popular fields. None provide instruction in the agricultural sciences, although the Rift Valley University offers courses on agribusiness-related topics. Similarly, the NGO sector provides

[11] For later reference purposes, note that the formal educational sequence and qualification system in Ethiopia is structured as follows: primary education from grades 1 to 6; secondary education from grades 7 to 12, of which years 11 and 12 are preparatory years for university; and tertiary education at university. Formal degrees in Ethiopia include certificates/diplomas (after year 10), B.A./B.Sc. degrees (three years following year 12), M.A./M.Sc. degrees, and Ph.D. degrees.

little in terms of formal AET, although it is worth noting that Menschen für Menschen, a German NGO well established in the country, is credited with piloting the model for the government's ATVET colleges with its Agro-Technical Training College, established in 1992 in eastern Ethiopia to provide practical skills training in agriculture and related fields.

Ethiopia's postsecondary AET system is complemented by a sizable public agricultural research and extension system. Research is led by the Ethiopian Institute of Agricultural Research (EIAR, formerly the Ethiopian Agricultural Research Organization), which accounts for the lion's share of expenditure and expertise.[12] EIAR is accompanied by seven regional agricultural research institutes, as well as extension services operating at the federal, regional, and district levels. Extension services are managed at the federal level by the Ministry of Agriculture and Rural Development (MoARD) and at the regional level by regional bureaus of agriculture; district-level offices are charged with providing direct outreach to farming communities.

Ethiopia's AET system has evolved in various directions over the years. In the last 15 years, key policy initiatives from the Government of Ethiopia (GoE) have included market-led reforms of the agricultural sector under the Agricultural Development-Led Industrialization (ADLI) strategy set forth in 1991; regional devolution of political, economic, and administrative power following the introduction of the federalist system in 1991; and large-scale education initiatives designed to reverse years of educational neglect and inequity (MoFED 2005, 2002; Beyene et al. 2005).[13]

In **Mozambique**, the Eduardo Mondlane University (UEM) serves as the central provider of higher education in the agricultural sciences through its Faculty of Agronomy and Forestry Engineering and Faculty of Veterinary Medicine, both established in 1963. But following Mozambique's independence in 1975, the departure of Portuguese technicians and professionals from the university and from the wider AET system has forced the country to play catch-up ever since.

In addition to UEM, there are three agrarian institutes that provide technical and vocational training in agriculture, as well as a teaching university established to train instructors for these and other institutes.[14] More recent AET additions include two agricultural polytechnics (established in 2005) that

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[12] As of 2000, approximately 66 percent of national expenditure on agricultural research and 58 percent of full-time equivalent (FTE) researchers employed were attributable to EIAR centers and programs (Beintema and Solomon 2003).

[13] The ADLI strategy prioritizes interventions that increase the ability of smallholders to generate the agricultural surpluses needed to fuel industrial production, thereby releasing the material and labor resources needed to accelerate industrialization. In recent years, the ADLI strategy has led to an emphasis on boosting the productivity and commercialization of smallholder farming; expanding high-value cropping, agro-industrial-based value addition, and value chain development; investing in export-oriented agriculture; and improving rural services. The international donor community has extended consistent support to the strategy, strengthened by the relative peace and stability that Ethiopia has experienced since 2001 (MoFED 2005, 2002).

[14] For later reference purposes, note that the formal educational sequence and qualification system in Mozambique is structured as follows: primary education from grades 1 to 7, of which grades 1 to 5 are compulsory; secondary education from grades 8 to 12, during which students may choose to pursue vocational and technical education after grades 8 and 9 or may continue on through grades 11 and 12 for university preparation and earn a diploma; and tertiary education at the university level.

are designed to convey practical skills for those to be employed by the government, NGO community, and private sector; and two private universities (the Catholic University of Mozambique [UCM] and Mussa bin Bique University), both established in the last decade. Other private universities such as the Higher Institute of Sciences and Technology of Mozambique and the Higher Polytechnic and University Institute have also emerged in recent years, although their curricula are not explicitly focused on agriculture. These new private universities (approximately 13, including non-AET institutions) currently represent about 32 percent of higher education enrollment in Mozambique, a figure expected to increase to 40 percent by 2010.

The formal AET system operates alongside Mozambique's public agricultural research and extension system. The Mozambique Institute of Agricultural Research (known by its Portuguese name and acronym, Instituto Investigação Agraria de Mozambique [IIAM]) serves the country as its mandated institution for agricultural research. IIAM was established in 2005 from a merger of separate institutes for crop, livestock, and forestry research. Agricultural extension and advisory services, introduced only in 1987, are managed by the Ministry of Agriculture (MINAG). The formal AET system also operates alongside a large NGO sector that provides agricultural extension and advisory services.

The Government of Mozambique (GoM) has pursued several different policy frameworks since the end of civil war in 1992, all of which have targeted poverty reduction, economic growth, and national stability, and all of which have emphasized agriculture and rural development (IMF 2005a). The latest poverty reduction strategy paper, the Action Plan for the Reduction of Absolute Poverty (PARPA), was developed within the framework of the GoM's five-year plan (2005–2009) and highlights a continuing commitment to the reduction of absolute poverty; sustained and rapid economic growth; consolidation of peace, justice, and democracy; and an end to corruption (World Bank 2006b; IMF 2005a; Falck, Landfald, and Rebelo 2003).[15]

This proactive policy environment has transformed Mozambique into a sort of "experimental playground" for the donor community, often pushing the country in several different policy directions at once. Thus, there is some concern that Mozambique needs to assert its own path and model of agricultural

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Formal degrees in Mozambique include certificates or diplomas (after 10 or 12 years of schooling), licenciatura (similar to a B.A./B.Sc. degree), and M.A./M.Sc. degrees. At present, there is no Ph.D.-granting institution in Mozambique.

[15] Note, however, that a study by Falck, Landfald, and Rebelo (2003) describes the policy-setting environment underlying the PARPA process as one of continuing political tensions, capacity constraints, and financial shortfalls, characterized by the absence of both a common fiscal framework and broad political ownership. Yet the researchers also argue that PARPA significantly improves the prospects for prioritizing poverty-reduction efforts by the GoM and better coordinating donor assistance. Thus, evidence strongly suggests that the implementation process has been accompanied by stable and effective governance leading to sustained growth and investment in Mozambique over the last six years. This enabling environment has allowed the GoM to pursue several ambitious reforms in AET, including the development of a higher education law that will not only reform financial systems in the education sector but will also create a system of quality assurance through accreditation and evaluation and will be complemented by government and private sector initiatives to establish new institutions in underserved parts of the country (Fonteyne 2005; IMF 2005b).

development that makes better use of its unique history and cultural ties in order to design and implement appropriate policies and programs (Eicher 2004).

4.1. Strengthening Individual and Collective Capabilities

Both Ethiopia and Mozambique are investing in efforts to strengthen their respective AET systems. Of course, they may not describe such efforts in the language used in this study—there are few papers in circulation that discuss efforts to "strengthen individual and collective innovative capabilities to build a better innovation system." However, there are some signs that both short-term localized experiments and long-term systemic improvements in AET are occurring.

In this section, we examine the changing scenarios in agricultural policies and markets in Mozambique and Ethiopia as drivers of change, and discuss their implications for the demand for AET professionals and graduates. Following this, we examine how these changing scenarios require new and different capabilities among AET organizations, professionals, and graduates, and how Ethiopia and Mozambique are responding to these requirements. We then discuss the educational approaches and learning philosophies being pursued in Ethiopia and Mozambique, and how they contribute to the development of new and different capabilities among AET organizations, professionals, and graduates.

Agricultural Markets and Policies are Changing Demand for AET

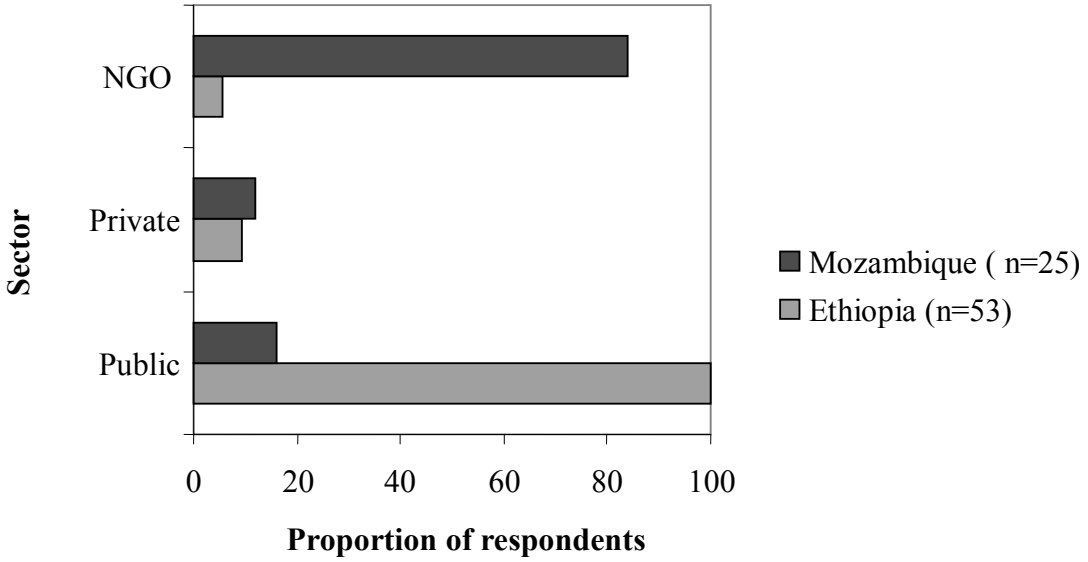
Public policy changes and changing market realities in Ethiopia and Mozambique suggest the beginning of an agricultural transformation from smallholder agricultural systems into more productive, diversified, and commercialized agricultural sectors. This transformation can generate significant demand for AET professionals and graduates as extension agents to facilitate commercialization of farm production, as managers and technicians in agroindustrial companies, or as entrepreneurs in dynamic subsectors of the agricultural economy (Figures 2 and 3). Although it may be difficult to identify medium- and long-term market demand for AET professionals, we attempt to show several emerging trends here.

In **Ethiopia**, the demand for AET graduates is primarily driven by the GoE's ambitious farmer training center (FTC) program, slated to deploy some 55,000 ATVET graduates as development agents (DAs) across the country. The FTCs are designed as local-level focal points for farmers to receive information, training, demonstrations, and advice, and include both classroom and demonstration fields. They are expected to form an important node between extension and farmers in the agricultural sector. Each FTC is to be staffed by three DAs (one each in the areas of crops, livestock, and natural resource management) and supported by a peripatetic DA covering several FTCs and trained in cooperatives management or a related field. Each DA is expected to train 120 farmers per year in his or her field of specialization.

The plan is generally proceeding as projected, at least in terms of quantitative outputs: sufficient numbers of ATVET instructors have been trained in and recruited from the university system, while the ATVET colleges are full to capacity and on track to produce the mass of DAs needed to fully staff the FTCs within three to five years.[16]

At the same time, the private sector has emerged as a potential source of demand for AET professionals and graduates. The nascent horticulture sector has expanded rapidly in the last several years, creating around 26,000 jobs for skilled and unskilled workers across the country (EHPEA 2006).[17] The cut-flower export industry, a key component of this sector, has contributed significantly to creating a modern innovation cluster in Ethiopia's agricultural sector and has attracted the attention of policymakers and entrepreneurs alike (World Bank 2004). Throughout the sector, opportunities exist for managers and semiskilled workers trained in areas such as plant production/protection, horticultural science, and farm management—opportunities that require mid-level qualifications rarely exceeding the B.Sc. level.

Figure 2. Key informant perspectives: Expectations of top three opportunities after graduation, by sector



Meanwhile, the NGO sector serves as another source of demand for AET professionals and graduates. Some 246 local and 122 international NGOs operate in Ethiopia, a significant portion of which

[16] Note, however, that there is some concern over the distribution and composition of AET training in Ethiopia implied by the FTC initiative. Abegaze, Tola, and Demeke (2004) argue that the AET system is currently producing an insufficient quantity of mid-level experts (such as extension agents) relative to the quantity of higher-level experts (such as researchers and managers) and relative to the human resource needs of the GoE's wider plans for agriculture and rural development.

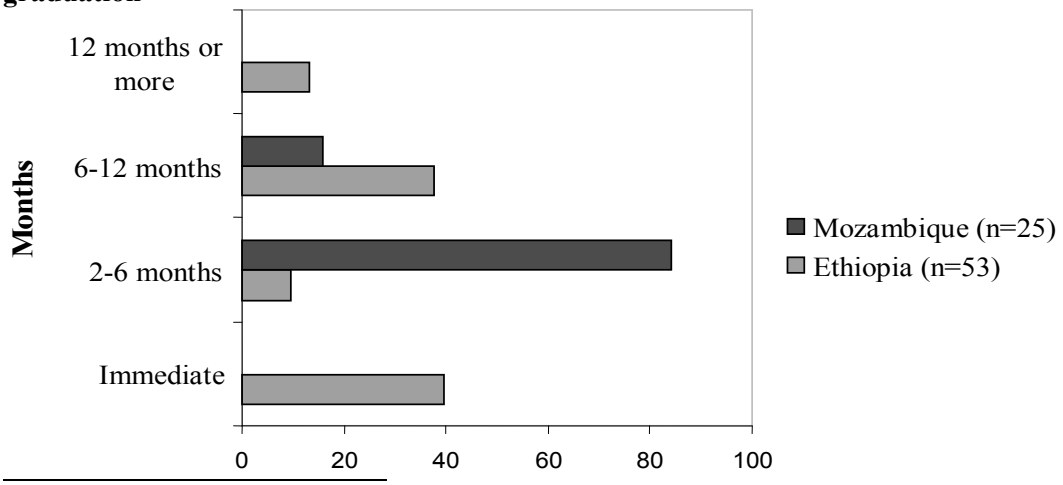
[17] The share of horticulture as a percentage of the total merchandise export has increased rapidly over the last five years, from 2.4 percent in 2001/02 to 3.4 percent in 2005/06. During these years, the total volume of floriculture merchandised increased from 6.7 million stems in 2001/02 to 21.9 million stems in 2005/06 (EHPEA 2006). Other horticulture products being produced for export include fruit and vegetables, primarily green beans, okra, and melons (Doney and Wroe 2006).

are active in agriculture and rural development. Such NGOs often hire workers with competencies in plant/animal production and protection, particularly when combined with skills in community mobilization and rural extension.[18]

In **Mozambique**, the demand for AET graduates has similarly grown with agricultural sector recovery and expansion since the end of the civil war in 1992. The GoM is the main employer of AET graduates, hiring to fill the ranks of extension agents in the provinces, teachers at the agrarian institutes and polytechnics, technicians in research stations, civil-service positions in MINAG, and, occasionally, posts in other government agencies outside the agricultural sector. However, public sector demand for AET graduates in Mozambique is fairly nascent: extension services in the country were established only in 1987 and employ fewer than 1,000 extension agents.

In Mozambique today, there is much discussion of employment opportunities outside public service for AET professionals and graduates. According to key informants to this study, employment opportunities are growing with the entry of large agroprocessing companies— many from neighboring South Africa—that operate in traditional cash-crop sectors such as cashew, cotton, tobacco, and fisheries. Significant employment opportunities also exist in the NGO sector. Mozambique is host to some 400 NGOs, and though they are largely concentrated in the capital, Maputo, some do operate in rural areas and thus hire AET professionals and graduates with skills in the agricultural sciences, community mobilization, and rural extension.

Figure 3. Key informant perspectives: Expectations of time needed to find employment after graduation



[18] Such is the case of Saskawa Global 2000 and its close relationship with Ethiopia's extension services—a relationship used to pilot the PADETES extension approach described earlier in some cereal growing areas of the country . Other NGOs that are active in the areas of agricultural research and extension include Agri-Service Ethiopia, FARM-Africa, ACDI/VOCA, and SOS Sahel (Zerfu and Agajie 2001), as well as local and regional NGOs such as the Relief Society of Tigray (REST) and the Oromo Self-Help Organization (OSHO). Their work often coexists with larger-scale activities by United Nations agencies such as the World Food Programme (WFP) and the Food and Agriculture Organization (FAO), and is conducted in partnership with the GoE at the regional, *woreda* (district), or *kebele* (local) levels.

A Changing Scenario Means Demand for New Individual and Organizational Capabilities

The potential and real demand for AET professionals and graduates is just one part of the story in Ethiopia and Mozambique. The other part, from an innovation systems perspective, is whether the AET system is developing individuals and organizations with the innovative capabilities needed to stimulate the growth of a more dynamic agricultural sector (Table 3).

Table 3. Key informant perceptions of the backgrounds and skills that employers are looking for in an AET graduate, Ethiopia and Mozambique [a]

Backgrounds that employers are looking for	Skills that employers are looking for
Agriculture and agricultural science	Practical/technical skills in agriculture
Community mobilization and social work	Skills in executing government programs
Agricultural education	Teaching skills
Agricultural business	Training and demonstration skills
Information and communications technology	Communication skills
Agricultural marketing	Agricultural business skills
General management and supervision	Business ethics and manners
Farm management and supervision	Skills in learning independently
	Creativity
	Problem-solving skills
	Ability to support and assist research

[a] Perceptions are unranked and based on unweighted responses from key informant interviews held with AET professionals, students, and administrators in Mozambique and Ethiopia in 2006.

In **Ethiopia**, this issue is not insignificant. While the GoE may be meeting its own quantitative benchmarks in terms of AET graduate output, many key informants to this study argue that few such graduates have the necessary capabilities to participate effectively in the country's changing agricultural sector. Indeed, there is concern that the GoE's emphasis on increasing access to education (including AET) has been pursued at the expense of quality and at the expense of developing individual capabilities to innovate.

Illustrations of the quantity/quality trade-off are not difficult to identify in Ethiopia's AET system. The "massification" of university education in AET has led to classrooms filled beyond capacity; class sizes that impede the delivery of practicum-based course components such as field or laboratory work; insufficient resources to fund either short- or long-term apprenticeships and practical attachments; and rapid depreciation of existing infrastructure and equipment.[19] The massive intake of students being prepared as DAs for the FTC initiative has similarly stretched the ATVETs. Resources allocated to many ATVETs are insufficient to conduct practical education (including training on tractors, combine harvesters, or other machinery, and experimentation with plant and animal breeding materials), to provide

[19] This point is raised with reference to Ethiopia's wider system of tertiary education. In examining the country's overall higher education system, Saint (2004) concludes that while enrollment expansion targets are likely to be met, Ethiopia may face formidable difficulties in maintaining educational quality.

students with the means to undertake practical attachments (by covering their travel and living expenses during long-term attachments in the private sector or with public extension services), and to appoint qualified B.Sc.-level instructors with sufficient experience and practical training.[20]

Several key informants to this study argue that Ethiopia's AET system is also failing the needs of industry, especially in the rapidly growing horticulture sector. They argue that the system is overlooking graduates' needs for practical, hands-on skills that balance abilities in the hard sciences with an understanding of the social and management sciences. Thus, private companies in subsectors such as the cut-flower industry—which is highly reliant on foreign technologies that are not traditional components of the AET curriculum in Ethiopia—draw their skilled employees either from foreign sources (the Netherlands, Israel, India, and China, for instance, or Zimbabwe, Uganda, and Kenya, where recent declines in flower farm operations have provided a surplus of experts for Ethiopia's growing industry) or from more senior local sources (experienced or long-time managers from moribund state farms or other state-owned agricultural enterprises).

These problems are not limited to the highly technical, modern "edge" of the agricultural sector. Several key informants suggest that the public extension system is grappling with similar issues with its DAs working with smallholders in the subsector. DAs are often expected not only to help smallholders boost their food staple yields and outputs, but also to assist in bringing their small surpluses to market, and organizing them into collective marketing associations (cooperatives). Few DAs have received training opportunities to adequately develop their potential in many of these areas.[21]

In recognition of the growing demand for new and different capabilities among AET organizations and professionals, the GoE has invested in several large-scale improvement efforts. For example, in 2001 it initiated the Agricultural Research and Training Project (ARTP) to promote a series of large-scale changes in the system's strategic orientation. The project provided much-needed strengthening of AET scientific and technical staff capacity, improvements in faculty incentives, and upgrading of facilities, and is being renewed with funding by the donor community.

More recently, many of the ATVET colleges and universities in Ethiopia have introduced or expanded their courses and specializations in areas such as horticulture science, cooperative management, finance and accounting, and the like. A growing number of private companies and NGOs have also

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[20] Part of the problem also lies in the declining quality of presecondary intake, an outcome of the GoE's "10+2" education strategy that has been in effect since the early 1990s (Beyene et al. 2005). The "10+2" system is designed to systematically transition students from 10 years of secondary education into continuing technical and vocational education or two years of preparation for university. While the technical and vocational track feeds directly into the public system of agricultural and nonagricultural training colleges, the university track tends to create students who are ill prepared for an additional three years at university. Many AET professionals interviewed for this study argue that the two preparatory years are taught by instructors with insufficient qualifications, experience, or materials to cover what is essentially a first-year university curriculum.

[21] See, for example, a study by Gebremedhin, Hoekstra, and Tegegne (2005) that captures the difficult roles played by DAs with insufficient capacity in market-driven innovation projects with smallholders across Ethiopia.

started offering short-term practical attachments for AET students to supplement classroom-based instruction.

At the same time, as part of its commitment to education, agriculture, and administrative decentralization, the GoE is constructing 13 new regional universities and upgrading two existing universities. The program, though largely focused on physical construction without concurrent reforms of the curriculum, educational approaches, or learning styles, will expand the AET system with the opening of new faculties of agricultural science and allied disciplines. Instructors are currently being recruited both domestically and internationally, with significant numbers being drawn from other developing countries such as Nigeria, India, and China.

In general, evidence thus suggests that the AET system is producing graduates who do not have many of the essential capabilities needed to contribute to a changing agricultural sector. Few key informants to this study felt that the current program of human resource preparation was sufficient to meet the country's growing needs for skilled AET professionals or dynamic AET organizations. Many key informants argue that the current program depends on curricula that are overly theoretical and conceptual, while management training is out of touch with modern methods. More importantly, several key informants suggest that the AET organizations are weakly responsive to the sector's needs; private companies, NGOs, and other stakeholders in the agricultural sector have little direct influence over the design of the AET system and its program to develop individual innovative capabilities.

Mozambique faces many of the same quantity/quality trade-offs as Ethiopia. The GoM has sought to increase access to AET by expanding enrollment and establishing new institutes in the provinces and closer to rural areas (outside the historically overrepresented Southern Province), by changing the entry and exit points so that students can cycle through the system at new and different education levels, and by changing the duration of programs to cycle students through the system faster (agrarian institute programs have been compressed from four to three years, for example).[22] The GoM has also begun experimenting (albeit tentatively) with modern technologies to strengthen the AET system, such as simplifying application processes for some institutions, with online application procedures for its new agricultural polytechnics, and exploring distance education options to upgrade the qualifications of extension agents located in remote parts of the country.

Unfortunately, few of these initiatives have been matched by improvements in either the quality or quantity of staffing or infrastructure. Greater student enrollment has made practicum-based coursework

[22] As in Ethiopia, Mozambique also faces an acute equity issue in increasing AET access. Several key informants to this survey noted that increasing access to postsecondary AET has resulted in a drop in the quality of student intake. Many students lack basic skills that are expected to be mastered at the secondary level. Yet historical experience suggests that higher intake requirements necessarily favor the urban elite from Maputo—those with the best secondary school education and thus the best admission test results.

increasingly difficult; large class sizes have made it difficult to administer field or laboratory components and have stretched already short supplies of infrastructure and equipment (such as planting materials, tractors, and laboratory equipment) beyond capacity. Moreover, greater student enrollment has, according to several key informants, reduced the quality of student intake, resulting in students lacking the basic skills needed to pursue higher education effectively.[23]

These problems partly reflect the argument that underlies the innovation systems approach used in this study—that Mozambique's AET system is generally not building capabilities that can potentially contribute to a more innovative agricultural sector.[24] In recognition of this finding, one particular initiative in Mozambique is worth noting: the creation of two new agricultural polytechnics. These institutions are a significant break from the traditional AET system in that they aim to address this very issue of individual capability development. The goals of the polytechnic programs include (a) teaching students "how to do it" and linking teaching and research to practical and relevant competency development and (b) combining agricultural and livestock sciences—a mix that does not exist at the university level, where faculties, which are organized according to the linear vision of science, are deeply separated. These new institutions' mandated focus on practical, hands-on education as a means of developing skilled technicians and self-employable entrepreneurs is likely to introduce a new set of competencies into Mozambique's agricultural sector, albeit on a small scale.

However, beyond this rather nascent example, many key informants suggest that Mozambique's AET system is not developing the innovative capabilities needed in a changing agricultural sector. Private sector employers are generally looking for workers for their agroprocessing activities, or for allied services such as input supply and financial services. More often than not, the private sector's human resource needs are simply not met by local technical or professional expertise, thus requiring recruitment from neighboring countries or other foreign sources. This is particularly true with respect to the country's large concessionary monopolies in tobacco, tea, and sugar.

Demand for New Capabilities Means Demand for New Educational Approaches

The preceding discussion suggests that developing new and different capabilities requires diverse educational approaches and learning philosophies, including informal and experimental approaches and philosophies adapted from local and foreign experiences as well as the formal ones that characterize

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[23] According to several key informants to this study, MINAG is exploring distance education to upgrade the skills and qualifications (for example, to a B.Sc. level) of its extension agents and other staff located in more remote parts of the country. The costs and complexities of such a system are being examined by IIAM, while UEM has piloted a program in agricultural sciences distance education.

[24] Similarly, Skelton et al. (2003) and Wingert (2002) find that the output of the AET system is largely characterized by a lack of basic, practical workplace skills and entrepreneurial attitudes, thus requiring additional investments in in-service or on-the-job training for graduates.

traditional AET systems. Such strategies aim to develop learning organizations and professionals in AET that effectively combine technical skills with more practical abilities in problem solving, decision making, integrating concepts, and acting independently and creatively.

Yet by and large, educational approaches and learning philosophies in both Ethiopia and Mozambique concentrate on traditional modalities of instruction (Figure 4), do not universally rely on the use of modern educational infrastructure or equipment (Figure 5), and provide professionals and graduates with only a limited set of technical skills and abilities. We examine some of the factors that cause these approaches and philosophies to persist in Ethiopia and Mozambique, and examine several departures from the norm.

Figure 4. Key informant perspectives: Common AET teaching methods in Ethiopia and Mozambique

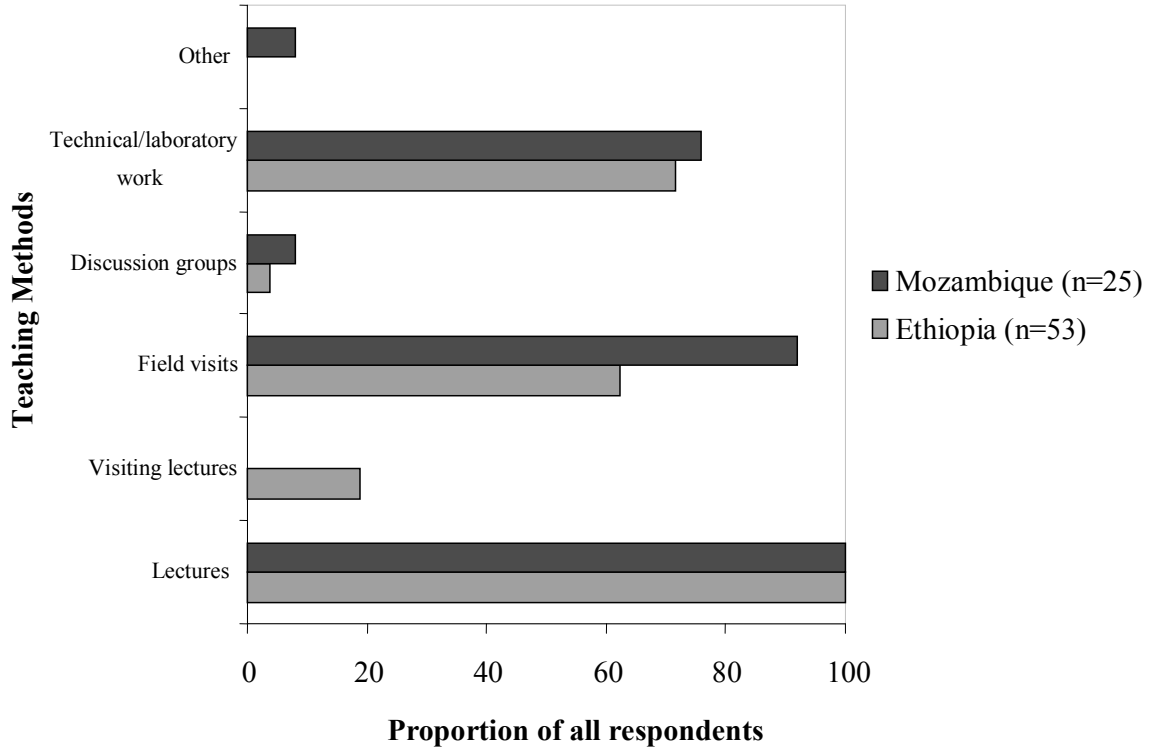
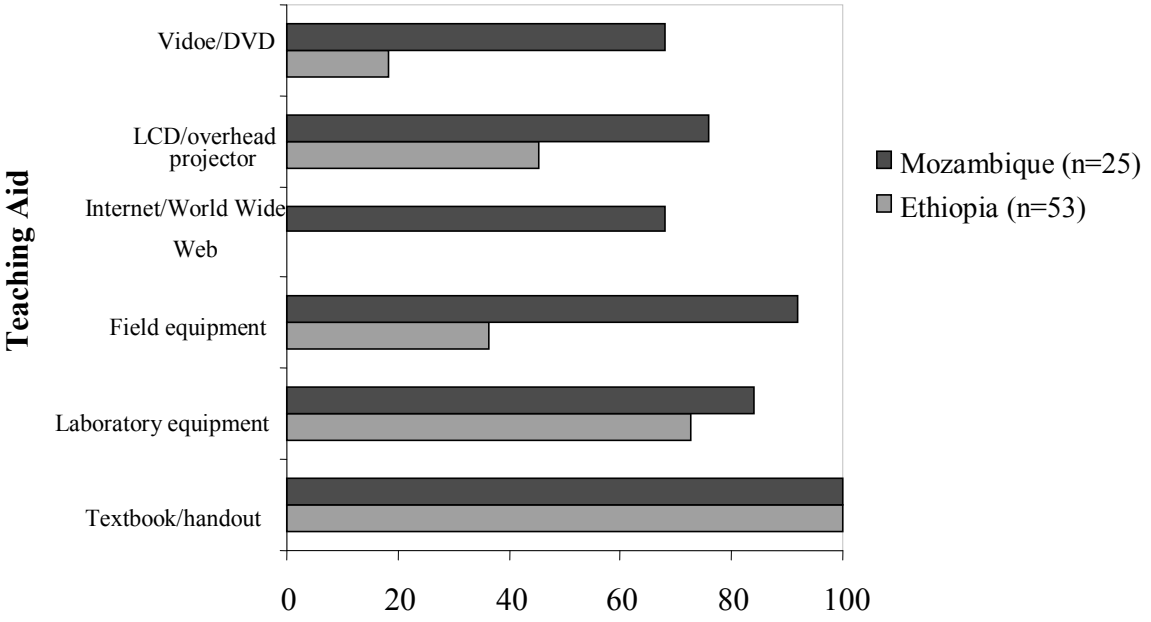


Figure 5. Key informant perspectives: Common AET teaching aids in Ethiopia and Mozambique



In **Ethiopia**, many key informants to this study acknowledge that the country's AET curriculum is driven by a deep and persistent emphasis on yields, output, and technologies rather than by a more holistic focus on innovation. This suggests that the AET system is producing yet another generation of extension agents, researchers, and educators who will continue the tradition of pressing for food security by pushing smallholders to produce more, and more efficiently. Few graduates of the AET system are cognizant of the more nuanced issues in Ethiopian agriculture, such as the need for better market infrastructure and market information systems; new ways to exchange knowledge and information between researchers, extension agents, and smallholders; and new ways to collaborate with market traders, agroindustries, and other market agents as part of the development process.

The university and ATVET curricula illustrate the magnitude of these problems within the formal AET system. Both curricula are organized along strict disciplinary lines: plant sciences, animal sciences, natural resource management, animal health, and a changing (and somewhat marginalized) milieu of soft skills such as rural extension, agricultural education, and cooperatives management. This strict disciplinary separation is at odds with the emerging belief that extension agents and other professionals must be familiar with a variety of disciplines and, more importantly, must be adept at being *facilitators*—solving farmers' problems by linking them to key experts in the agricultural sciences or to opportunities with market agents. Thus, several key informants to this study argue for more courses in agribusiness and marketing; agroprocessing/postharvest technologies; agricultural operations and project management; accounting and auditing; community development and social organization; leadership, conflict management, and human resource management; and general issues in rural development.

Though they are meant to balance formal instruction and practical training, teaching styles and methods in Ethiopia's formal AET organizations are overwhelmingly dependent on classroom lectures. Andragogical approaches are often limited to direct, traditional methods of chalk-and-talk. Lectures and materials at the tertiary level (ATVET and university) are in English, although students' command of the language is often quite limited. Alternative means of accessing information, such as the Internet, are unavailable, use-restricted, or prone to infrastructural breakdowns, while libraries are poorly stocked with up-to-date materials.

Part of the problem lies in excess enrollment and class sizes that make practicum-based teaching difficult, as well as shortages of equipment for field and laboratory work and limited budget resources for anything beyond routine classroom activities. Another part of the problem lies in the fact that the instructors themselves were educated by traditional methods and are thus unfamiliar with new andragogical approaches. The few who venture to explore new approaches often do so independently, with little or no external support.

Yet beyond the classroom, there is the wider issue of Ethiopia's AET curriculum. The curriculum content tends to overlook the importance of creating opportunities for AET students to build practical life skills and decision-making abilities in the context of a more dynamic and innovative commercial agricultural sector. This includes skills that combine technical expertise, analytical competencies, and independent and creative thought. Moreover, it includes the ability to search for and share information (for example, from the Internet), and to relate this information to people of different backgrounds (for example, farmers). Yet many students interviewed for this study readily acknowledged *both* a lack of confidence in working with farmers and an unfamiliarity with the Internet.

The curriculum-development process in Ethiopia tends to exacerbate these problems. Few institutions have formal curriculum-development processes that link directly to their budgetary and programmatic planning cycles. As a result, most new courses, programs, or faculty bifurcations and mergers are ad hoc and are rarely based on solid market research, tracer studies, or consultations with industry and other employers. Worse yet, these upgrades often require expertise that is rare in Ethiopia; even the most senior administrators in the GoE interviewed for this study admit to their own lack of expertise in AET curriculum development.

There is, however, some evidence of change at a systemic level. There are signs that AET organizations are incorporating demand-side needs in the curriculum to a greater degree. Stakeholder workshops, formal consultations, and informal interactions among government, industry, and NGOs on issues relating to AET curriculum are increasingly commonplace. Efforts have also been made at the institutional, regional, and federal levels to patch up the AET curricula with new structures and courses.

For example, the ATVET curriculum was revised in 2003/04 with the introduction of courses in business management and horticulture as a response to the growth of commercial horticulture in Ethiopia.

More informal AET approaches are also becoming popular, and are largely geared toward reversing the overly conceptual and impractical nature of AET at all levels. For example, AET organizations are now putting greater emphasis on practical attachments to private firms, NGOs, or district extension services, ranging from several weeks to an entire year, depending on resource availability. Horticulture operations and other agribusiness firms are providing on-the-job training and apprenticeships for new recruits from the AET system and are slowly building closer linkages to research, extension, and education as a way of generating the human resources they need.

The nonagricultural technical and vocational education and training (TVET) system is also undertaking reforms that may lead the way for parallel changes in the ATVET system. Key reforms include the introduction of a modular curriculum that balances practical skills development with thinking skills (such as courses in reading and understanding technical drawing) and common skills (such as English language, small business management, and information and communications technology) as well as the introduction of outcome-based system reforms designed to bring TVET more in line with the needs of industry. Highlights of the reforms include provisions for stakeholder workshops and consultative processes that focus on identifying occupational standards—the skills that must be imparted by TVET to meet regional or international standards for a given industrial sector.

Still, many key informants to this study argue that educational approaches and learning philosophies in Ethiopia remain top-down; AET professionals are rarely cognizant of either modern advances in education and learning or the critical importance of a dynamic, adaptive, and innovative workforce. This has serious ramifications for the hopes of commercializing and modernizing the country's largely smallholder agricultural economy.

In **Mozambique**, findings from this study suggest a far different philosophy underlying the AET system that has nonetheless resulted in similarly ossified educational approaches and learning philosophies and a deep emphasis on theoretical and conceptual (rather than practical) competency.[25] The country's colonial heritage has left behind a strong culture of elitism, in which social status is attained and held by progressing through higher education and eschewing practical employment and association with agricultural livelihoods. In short, many AET graduates in Mozambique prefer not to get their hands dirty.

[25] These findings are echoed by Mário et al. (2001) and Mário et al. (2002) in separate studies of Mozambique's wider educational system. These studies identify the constraints imposed by limited Portuguese language–based materials, geographic biases in Mozambique's higher education system, and a strong elitist tradition that results in students being drawn primarily from urban or well-to-do families. Recommendations include curricula reform, the upgrading of teachers' skills, improvements in the availability of learning materials for both teachers and learners, reforms in the system of providing student scholarships, a review of entrance requirements, and greater use of distance learning and information and communications technologies to improve access.

Formal AET in Mozambique is thus focused on getting a degree, with little reference to the development of practical skills in areas such as problem solving, decision making, integrating knowledge, hands-on technical work, or management. Curricula and learning philosophies remain grounded in traditional lecture-style approaches. The result: graduates without "real-world" skills who require extensive reeducation when employed outside public service.

Another issue facing AET in Mozambique is the country's acute linguistic isolation. Portuguese competency is an admissions requirement for universities and other AET organizations, but many students from the rural areas, especially outside the Southern Province where Maputo is located, are rarely equipped to handle a higher education program in the language. The linguistic isolation of the students is often compounded by a similar isolation of the AET faculty: their limited capacity to work with the extensive body of English-language materials available in the agricultural sciences and related fields, coupled with the relative scarcity of Portuguese-language educational materials, teaching aids, and information sources, makes lusophonic educational approaches highly problematic.

Formal AET in Mozambique also suffers from a disproportional emphasis on the hard sciences, with little appreciation for a high-quality social sciences curriculum. This continues despite the recognized need for expertise in such areas as agricultural extension, social work, and community mobilization as well as agribusiness, agricultural policy analysis, and more traditional disciplines such as economics and sociology. And though efforts to link the social sciences curriculum to regional and global sources of knowledge have been initiated at UEM and other organizations, they have met with limited success due to linguistic, resource, and other constraints.

Furthermore, and in spite of this hard-science emphasis, few M.Sc.-level students have basic research skills; few are able to adequately propose a research project, analyze data, or write up their findings, and even fewer are able to assist in more complex faculty research projects. Thus, faculty spend an inordinate amount of time supervising theses of poor quality, which takes them away from other research and teaching projects of greater consequence. Of course, this is partly a reflection of limited capacity within the faculty itself—weak capacity not only to write proposals and conduct research, but also to impart these skills to students.

There are several reform efforts underway that may effect change in AET educational approaches and learning philosophies in Mozambique. The introduction of a competence-oriented (practical) curriculum in the two agricultural polytechnics discussed earlier is a bold attempt to address this problem—not only by producing graduates who are endowed with practical skills and are ready for employment or ready to work as self-employable agribusiness entrepreneurs, but also by presenting a model for replication by other organizations.

Curriculum reforms based partly on market analyses have also led to the introduction of several new educational approaches and learning philosophies, including new subjects that provide more general education skills and are less specialized; overview courses in multiple subjects for incoming students; shorter courses in single specialized subjects; optional courses that allow students to explore their interests more generally; and nonscience courses that include management, project cycles, commercialization and marketing, economics of production, rural extension, and computer skills.

For example, UEM undertook a reform of its curricula in 1999/2000 to provide more practical training. UEM has also been experimenting with new educational approaches and learning philosophies. Student-based learning is the new mantra in several UEM faculties, fostering a new perception of teachers as "coaches" instead of "drill sergeants," especially among senior-level students.

Another encouraging initiative is the GoM's commitment to upgrade AET personnel. MINAG targets include the immediate upgrading of AET professionals at all levels through both domestic and foreign training. Unfortunately, such upgrading efforts have also led to organizational uncertainty. The constant flux of staff coming and going—pursuing their M.A./M.Sc. and Ph.D. degrees at either domestic or foreign institutions—makes it difficult to maintain courses and programs and retain institutional memory. Moreover, staff who pursue higher education abroad often tend to leave their institutions for jobs in international organizations or foreign universities. The high turnover necessarily leads to additional costs of recruiting, orienting, and training new staff, to say nothing of weak morale.

Other proactive experiments are likely to emanate from the private universities, such as UCM's decision to adopt a more anglophonic educational approach rather than the traditional lusophonic one. Such an approach may help reduce the linguistic isolation suffered by students and faculty, and may pave the way for the adoption of new and innovative educational approaches and learning philosophies. However, the underlying issue will remain: current educational approaches and learning philosophies in Mozambique do not adequately develop individual or organizational capabilities to innovate.

4.2. Changing Organizational Cultures, Behaviors, and Incentives

From an innovation systems perspective, efforts to develop individual and collective innovative capabilities are contingent upon changes in the cultures, behaviors, and incentives that characterize AET organizations and systems—characteristics that differ significantly in Ethiopia and Mozambique. This is partly due to the fact that AET in Mozambique developed out of a colonial experience under the Portuguese, while AET in Ethiopia emerged from its long independence from direct colonial control. It is also partly due to the different agricultural policies, strategies, and programs pursued by the two countries' respective governments.

However, when looking at the AET systems of both countries from an innovation systems perspective, the outcomes are fairly similar and, in terms of future growth and development prospects, are of great concern. In this section, we discuss the organizational cultures prevalent in both AET systems, the incentives facing AET professionals and graduates, the financing sources that support these systems, and issues relating to gender in AET.

Organizational Cultures

As mentioned earlier, organizational cultures reflect shared beliefs. Discussions with key informants to this study suggest that in both Ethiopia and Mozambique, AET organizations and professionals hold several shared beliefs about agricultural development, food security, and poverty reduction that define the roles and functions of AET in both countries. First, it is commonly held in both countries that food security and food self-sufficiency are largely synonymous. Second, it is commonly believed that the development and dissemination of new technologies to smallholders will generate the yield and output increases that are critical to achieving food security and reducing poverty. Third, there is a shared understanding that the formal AET system's role is to create the researchers and extension agents who develop and disseminate these technologies.

These shared beliefs are not unreasonable in and of themselves. To be sure, there is ample experience from the Green Revolution in Asia and Latin America during the late 1960s and early 1970s to support such beliefs. From an innovation systems perspective, however, the concern is that these beliefs emanate from a rather mechanistic application of the linear vision of science (described earlier) that does not adequately account for the uniqueness—the inherent differences in markets, institutions, history, governance, and culture—of each country.

As a result, policies in both agriculture and education focus almost exclusively on science-based strategies to boost yield and output through what amounts to simple technology package transfers to smallholders. Yet in a vibrant innovation system, efforts to promote agricultural development would be more broadly defined as a combination of efforts to develop innovation clusters, value chains, contracting arrangements, and other systems that combine *technological* improvements in production, processing, and distribution with *organizational* improvements in how information and knowledge are exchanged between various actors in these systems, and with *policy* changes that create favorable incentives and institutions to promote change.

This mechanistic understanding of how to foster innovation is reflected in how AET organizations function in both countries. For example, several informants in Ethiopia argue that these shared beliefs manifest themselves in the fact that the AET system is entirely geared to the search for an intervention model or package to boost agricultural production that can be scaled up to a countrywide

campaign.[26] There is relatively little interest in the idea that multiple and diverse models—several "best fit" solutions for unique situations—are relevant to creating a responsive, dynamic, and innovative agricultural sector.[27] In Mozambique, shared beliefs about *who* should receive higher education (and thus conduct agricultural research and extension) are reflected in the elitist organizational cultures discussed earlier.

Organizational cultures in AET organizations in Ethiopia and Mozambique are also largely determined by administrative practices, public service regulations, and organizational incentive structures that determine how public administrators view their role in the agricultural development process. The shared belief, evident in discussions with many key informants to this study, is one in which AET professionals administer change and development from above, resulting in a common acceptance of top-down management practices based on strict adherence to rules and control of staff. As a result, few AET organizations in either Ethiopia or Mozambique are host to cultures that respond rapidly to changes in their external environments; rather, they are internally preoccupied with their own systems, rules, and routines. Thus, many key informants to this study focus their discussion of problems on organizational hierarchies, administrative procedures, resource distribution, and other internal, primarily structural issues. The resulting inertia that underlies these organizational cultures reflects the possibility that AET systems in Ethiopia and Mozambique could, without in-built mechanisms to change in response to external conditions, become obsolete.

Organizational cultures in both countries are also driven by donor beliefs and priorities that often influence or constrain the policy choices available to governments. According to several key informants, donor-financed and donor-designed AET projects in both Ethiopia and Mozambique have been particularly influential in motivating organizational reform efforts in both countries. In Ethiopia, for example, this has included the 2001 Agricultural Research and Training Project (ARTP, discussed earlier); in Mozambique, it has included various reform efforts in the UEM, IIAM, and the Ministry of Education and Culture (MoEC). But several informants have argued that this dependence on donor projects has led to continuous changes in beliefs and strategies relating to AET, and, as a result, changes in organizational cultures and practices.

Thus, AET professionals in Ethiopia argue that they have weathered the introduction of such "fads" as integrated rural development projects, farming systems research, training and visit (T&V)

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[26] For example, the GoE adopted the Participatory Demonstration and Training Extension System (PADETES) approach in a nationwide campaign in 1995 to increase crop yields and output following a successful piloting of the approach by Sasakawa Global 2000, an NGO operating in Ethiopia and other countries in the region. Whether the approach performed as expected—and whether it was significantly different from previous approaches at the ground level—remains a subject of debate. See Spielman et al. (2006) and EEA/EEPRI (2006).

[27] For example, Birner et al. (2006) offers a review of best-fit models in agricultural extension.

extension, participatory research and extension, and any number of other approaches. With each approach comes a major shift in organizational practices—how students are taught and what types of resources and infrastructure are needed to teach them—and continuous dependence on changing donor beliefs. Thus, while Ethiopia has a long and demonstrated tradition of developing policies independent of donor priorities and pressures (for instance, by funding agricultural research largely from its own budgetary resources rather than from direct donor support, an approach otherwise uncommon in the region), organizational cultures in AET remain closely tied to shared beliefs among donors.

Individual and Organizational Incentives

Incentive mechanisms in the AET systems of both Ethiopia and Mozambique are largely driven by public sector rules of service (Table 4). Thus, AET organizations in both Ethiopia and Mozambique are host to several realities (common to many countries in Africa) that motivate the behaviors and practices of AET organizations and professionals. AET educators are poorly paid and receive relatively few benefits, a reality compensated by the long-term benefits of secure employment, public pension schemes, and low expectations in terms of output. Similarly, AET graduates are typically consigned to relatively low-paying positions in public extension services, research organizations, or teaching organizations, often in remote areas disconnected from urban centers. These incentives tend to contribute weakly to organizational cultures that are supportive of innovation.

Table 4. Estimated salary and benefits for university or technical/vocational instructors in AET, Ethiopia and Mozambique, 2006 (US$)[a]

Qualification	Annual base salary plus benefits [b]		Costs covered for participation in national conferences and/or in-service training	
	Eth	Moz	Eth	Moz
B.Sc./B.A.	1,646	7,200	√	√
M.Sc./M.A.	3,037	8,400	√	√
Ph.D.	4,048	12,000	√	√

[a] Exchange rates calculated at ETB/US$ = 8.7 and MTL/US$ = 26.2.
[b] Typically housing, either on-campus or outside, and/or transportation.

Few other incentive mechanisms exist to create cultures of innovation in AET organizations in either Ethiopia or Mozambique. While professionals may receive funding to attend professional conferences or training events at a national level, there is little access to funds for independent research, attendance at international events, or other opportunities that might provide AET professionals with opportunities to exchange knowledge with other AET professionals, experiment with new AET modalities, or explore new and innovative avenues of possibility.

In Ethiopia, while instructor remuneration is in line with civil-service salary scales, it is apparently an insufficient incentive to retain professionals, particularly in the ATVET colleges, where turnover is high. Instructors and faculties have little control over their finances, while administrative systems, management practices, and financing mechanisms are typically focused on maintaining strict control and accountability over resources. Exacerbating this problem is the lack of sufficient capacity at either the individual or organizational level to translate individual leadership into effective AET organization and management. The resulting incentive and financing system is thus characterized by a top-down administrative system that prioritizes performance assessed only in terms of numeric or quantitative outputs with little reference to relevance or quality.

In Mozambique, while remuneration and benefits are low, it is the near-constant state of change in the AET system that poses problems for the development of innovative organizational cultures and practices. Curricula reforms, new performance evaluation systems, and infrastructural expansions are all part of the change process and have resulted in a perpetual state of flux that makes it difficult for AET professionals to evaluate whether changes are actually affecting the AET system's performance. Key informants to this study do suggest, however, that things are not working as expected, primarily because the system has not yet been given time to learn from these changes and let new structures, incentives, and financing settle into new practices and behaviors.

Thus, NGOs are a particularly popular destination for mid-level AET graduates (diploma holders from the agrarian institutes) who have more practical skills than their university-educated counterparts. NGOs are also known to "poach" employees from the public sector, often because NGO salaries and benefits are viewed as preferable to those offered by the civil service. According to several key informants to this study, the average monthly government salary for B.A. holders in public service is about US$600, while NGOs offer as much as US$1,400 for workers with the same qualifications. For motivated AET graduates, NGOs also offer an opportunity to undertake high-quality applications of their learning with sufficient resources to back them up—something not typically found in public service.

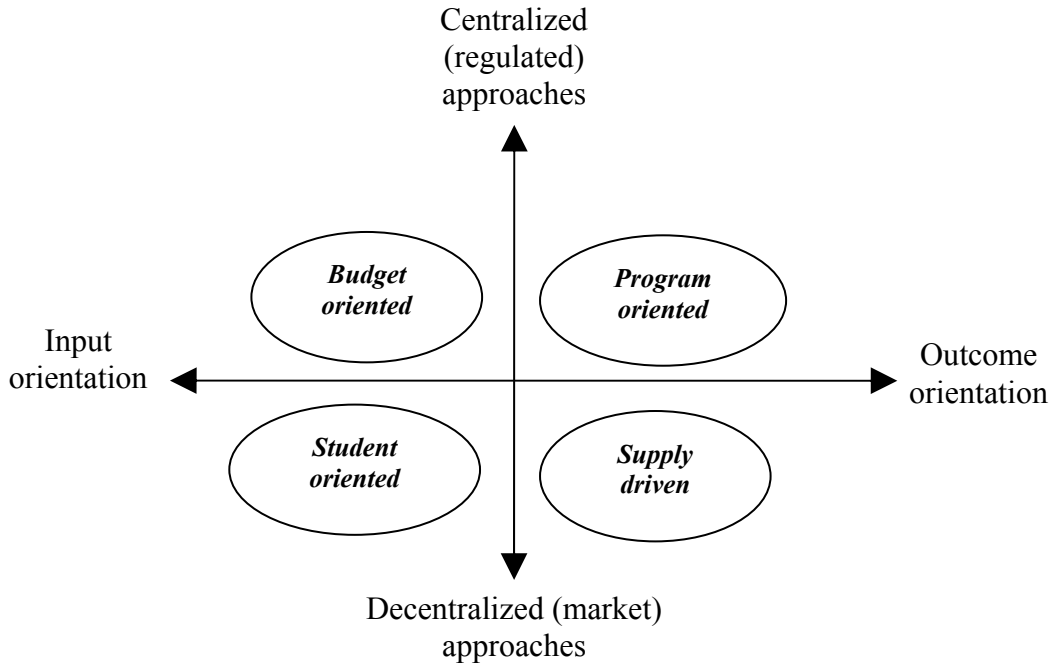
There are some signs that incentive structures are changing in Ethiopia and Mozambique, specifically through efforts to upgrade AET instructors' qualifications, introduce more practical education through curricula reforms, invest more in AET infrastructure and equipment, and reach out to stakeholders in industry and the NGO sector—points discussed earlier. The entry of foreign investors and technologies into some subsectors of the agricultural economy (such as high-value horticulture) may also be creating new opportunities and incentives for AET professionals and graduates. Higher-paying job opportunities and short-term contracts in both the private and NGO sectors may be motivating a new generation of AET graduates to excel not only as technical experts but as independent entrepreneurs and innovators as well. However, there is limited empirical evidence to suggest that new incentive structures

(or market realities) are yet generating the desired changes in organizational culture in the AET systems of Ethiopia and Mozambique.

Organizational Financing

Organizational cultures, behaviors, and incentives are also determined by systems for organizational financing. Both Ethiopia and Mozambique are host to centralized systems of educational financing (Figure 6). Both countries rely primarily on budget-oriented systems in which AET is financed by the state through annually negotiated budgets rather than alternative methods such as program-oriented financing (based on a performance formula whereby the state pays for the number of credits accumulated by the students, for example), supply-driven financing (where the state awards contracts for the supply of a number of graduates through a competitive tendering system), or student-centered financing (where institutions' core funds are supplied through students who are funded through a voucher or bursary system (MoEC 2006; Jongbloed 2004). Moreover, sizable gaps exist in both countries between those who make policy and allocate resources with respect to AET, and those organizations charged with executing the decisions and employing the allocated resources. Current practices allow little room for experimentation or exploration of new and innovative AET practices.

Figure 6. Alternative educational funding systems



Sources: MoEC 2006; Jongbloed 2004.

Still, some of the standard financing systems are changing in both Ethiopia and Mozambique—albeit in fits and starts—as the result of a recognition of the shortcoming of current AET practices and the growth of a more dynamic private sector in agriculture. New forays into the decentralization of finance, administration, and management are allowing AET systems to diversify their offerings with new, more informal programs and courses. Ad hoc examples are emerging that suggest a new scope for program-oriented and student-centered financing systems within individual organizations or levels of education.

In Mozambique, the MoEC's reform agenda includes provisions to increase efficiency by reducing the years spent by a student in the system and shift into a financing system that is more dependent on diversified funding. Highlights of the MoEC's new higher-education financing model include:

- greater cost recovery through the introduction of higher fees at all levels,
- the earmarking of institutional funds for special projects,
- scholarship funds for students that are administered through the student instead of through the university,
- direct budgetary support combining core funding with per student subsidies,
- independent project fundraising by research faculty, and
- the establishment of public funds for industry-relevant research.

If and when these types of financial reforms are put into place, they may have a significant impact on AET delivery and performance in Ethiopia and Mozambique. However, several key informants to this study argue that most financial reforms to date have been superficial or ad hoc, and express little confidence in new initiatives. Moreover, they argue that these reforms have raised the issue of how to manage processes of rapid systemic change and how to maintain educational quality in the face of scarce resources. These issues are particularly important in a country where rapid, ad hoc solutions developed by governments, donors, and other stakeholders can deeply influence the AET system, even without increases in per student expenditure to meet international and regional levels.

Organizational Culture and Gender

Finally, it is worth noting that underlying most organizational cultures and behaviors is a gender dimension that is rarely taken into consideration. Gender inequality is a constant theme in any analysis of agricultural development in Sub-Saharan Africa and is thus relevant to the study of AET systems that participate in the development process (Blackden et al. 2006; Quisumbing 2003). Although women play multiple roles in agriculture and account for more than half of agricultural output in the continent, they have continuously received a less-than-proportionate share of investment in agriculture, particularly in

terms of interventions relating to education, extension, capacity strengthening, empowerment, and market access (Alawy 1998; Frank 1999; Haug 1999). Recognition of these facts is rarely a visible component in AET organizations. Thus, women are underrepresented as students, instructors, extension agents, and researchers, while agricultural innovation processes are rarely targeted to female users (see, for example, Beintema 2006). Based on anecdotal feedback from key informants, this section attempts to illustrate several larger issues relating to gender and organizational culture in the AET systems of Ethiopia and Mozambique.

Gender inequities persist in Ethiopia's education system, despite recent national efforts to encourage schooling among the female population. At the primary level, gross enrollment rates are more than 20 percent higher for boys than for girls, with 76 percent of boys enrolled nationwide and only 55 percent of girls as of 2003 (WDI 2006). Girls who do enroll are more likely to drop out, with the highest number of dropouts in grade one. This enrollment problem carries over into the formal AET system. Across the country's 25 ATVETs, females accounted for only 11.3 percent of the enrolled students and 8.7 percent of graduated students in 2005. Female instructors accounted for only 5.7 percent of the total instructors in the ATVETs in the same year (MoARD 2006, 2005).

Similar gender imbalances also appear at the university level. In Haramaya University's School of Graduate Studies, a part of the College of Agriculture, female graduates accounted for only 2.8 percent of the total graduates over the period 1979–2003. This underrepresentation of female students in graduate studies is the result of a very low female student population in undergraduate programs—7.6 percent during the same period (Kassa 2004a).

But statistics paint only half the picture. Consider the ATVET curriculum from a gender perspective. The curriculum contains few, if any, courses on issues such as household nutrition, sanitation, and hygiene—areas in which women play a vital role and which are critical to household welfare, as empirical evidence from across the region has repeatedly demonstrated. Moreover, the curriculum provides few gender-specific tracks for female students entering public service. Female students are expected to work in FTCs and interact with farmers—primarily male and often senior to them in age—as would their male counterparts, often defying the traditional conventions and norms of local communities. Little effort is made to use AET and female AET graduates as a means of effecting change in rural livelihoods through gender-specific impact pathways. Thus, without detracting from the accomplishments of the many successful female extension agents in Ethiopia, it is worth asking whether the marginal impact of their effort could be better leveraged to influence behaviors and practices in rural households where gender-specific expertise is most needed, provided an appropriate curriculum was developed to support this.

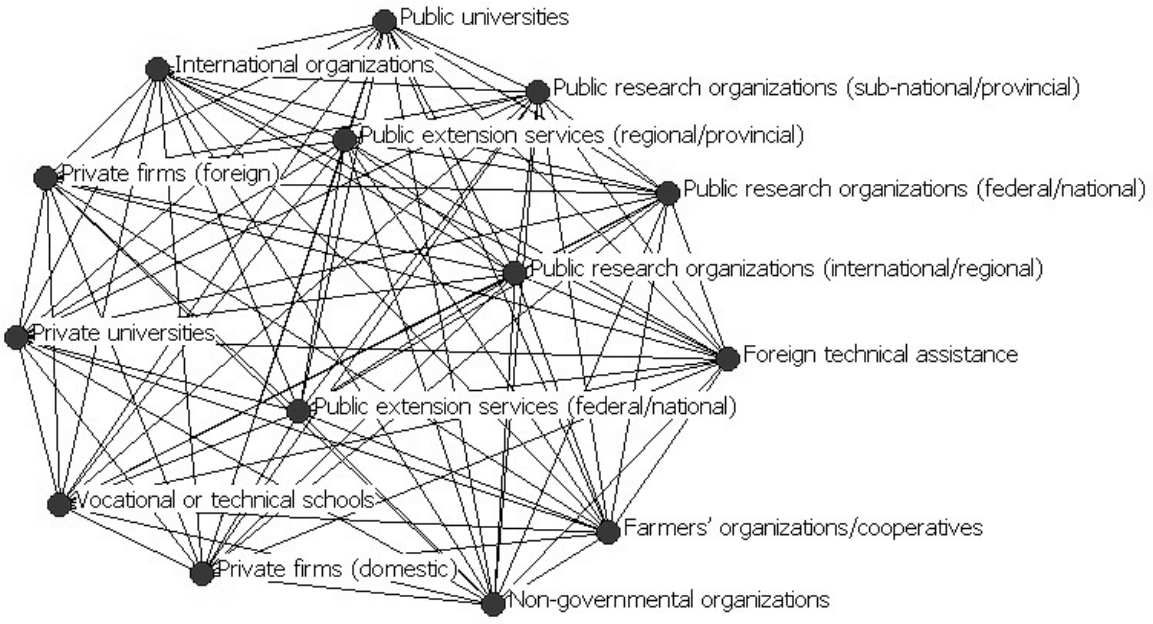
Like Ethiopia, Mozambique is actively promoting a policy of gender equity in education to address historical disparities in enrollment. Today, gross primary enrollment is near universal for Mozambique's primary school–age population, with female enrollment only slightly lower than male enrollment (WDI 2006). At the tertiary level, gender imbalances become more obvious—the female enrollment rate in higher education is 0.2 percent, whereas it is 0.5 percent for males. In AET faculty positions, women make up approximately 40 and 50 percent of the Faculties of Agronomy and Veterinary Science, respectively. Women make up about 20 percent of the staff at the Boane Agrarian Institute. More often than not, their recruitment is based on the availability of a qualified professional rather than on a policy effort to reverse historical gender biases.

There are several trends in Mozambique that suggest new opportunities for women in AET. First, the opening of private universities in Mozambique has led to new options for women seeking higher education, thus increasing female enrollment rates. Distance education programs (though currently at the exploratory stages only) may offer chances for female students who are also engaged in family responsibilities. Yet apart from these trends, there is little more to suggest any greater awareness or responsiveness to gender issues and gender bias in Mozambique's AET system.

4.3. Building Innovation Networks and Linkages

The development of individual and organizational capabilities to innovate requires not only supportive organizational cultures, behaviors, and incentives, but also effective innovation networks. These types of linkages are essential to achieve economies of scale and scope, reduce transactions costs, exploit complementarities among organizations and individuals, and realize synergies in the innovation process.

Figure 7. Hypothetical innovation networks in an AET system



The dynamism of an AET system relies partly on its ability to interact with agents in the wider innovation system through what we have described earlier as innovation networks (Figure 7). Here, we highlight one particularly important aspect of networking—the notion that innovation occurs in the nontraditional—rather than traditional—links of a network. A traditional link might consist of AET professionals discussing their latest research findings in an academic conference setting; while such a link is simple and durable, it may not generate desirable innovative outcomes. A different type of link—such as the interactions between an AET professional and an agroprocessing plant manager who, traditionally relegated to separate domains, are given an opportunity to collaborate on a specific problem-solving effort—may offer greater potential to generate innovative outcomes. We use this premise to explore innovation networks and linkages in Ethiopia and Mozambique.

Innovation networks in both countries revolve around the traditional links of academic and other networks comprised of similar individuals and organizations. Thus, AET professionals might all attend the same annual conference in their discipline, publish together in the same proceedings volumes, and generally share ideas with the same small group of colleagues year after year.

Nontraditional links—where new knowledge and information can be exchanged, and where innovation is most likely to occur—are few and far between. They might include networks between public breeders and agroindustrialists looking for improved crop varieties to process into consumer foods, or researchers, extension agents, and NGO workers trying to address a farm-level production constraint caused by a pest infestation. Few incentives exist to promote network formation, although several exceptions suggest possibilities for change.

Findings from **Ethiopia** suggest that AET remains largely de-linked from the wider innovation system. Key informants to this study suggest that despite the importance of AET to public extension services—and therefore to agricultural development—the system is only weakly linked to other public sector sources of innovation, namely agricultural research organizations. Key informants also suggest that the AET system is effectively de-linked from newer players in the system, such as private companies and civil society organizations.

These observations are reiterated in previous studies of AET linkages in Ethiopia. For example, Kassa (2005, 2004a, 2004b) argues that Ethiopia's AET system requires stronger linkages between education, research, and extension to meet the same development objectives. Gebremedhin, Hoekstra, and Tegegne (2005) further highlight this linkage issue by focusing on local-level relationships between research, extension, and education. They describe the system and system linkages as largely top-down, supply-driven, unimodal, and driven only by the public sector. They identify a need for further evaluation of the system to better gauge its effectiveness in producing graduates with skills appropriate for conducting extension based on more participatory modalities and greater commercial orientation.

Some successful experiences and structures suggest that these issues are being addressed. Organizations such as the Ethiopian Institute of Agricultural Research (EIAR) are experimenting with new approaches to innovation that move beyond the conventional transfer-of-technology approach, as suggested by public efforts to link smallholders with technologies, markets, businesses, and other key actors and institutions. Examples such as public breeding of durum wheat undertaken in partnership with a private pasta firm and public extension services to improve the quality and competitiveness of domestic industry suggest that change is under way. However, the wider culture of innovation still remains fairly top-down and driven by the "campaign" approach noted earlier.

Structures such as the Federal Research and Extension Advisory Council work to foster linkages among researchers, educators, extension agents, and farmers at the federal, regional, and research-center levels, and are comprised of representatives from across the innovation system. Councils at the regional level and within specific research centers are structured similarly to achieve similar goals.

Yet feedback from key informants suggests that the system, having undergone repeated restructurings and transformations, is still plagued by weak linkages between and among key actors. Although efforts are being made to set priorities and create structures that promote greater integration, there is limited empirical evidence to suggest that the requisite linkages are forming, that incentive structures to promote linkage formation are being designed, or that linkages are effectively integrating the critical end users—the small-scale, resource-poor farmers.

Thus, there is insufficient integration of activities performed by researchers, extension agents, educators, managers, and administrators at the federal, regional, and local levels, and even less integration or cooperation with other actors in the innovation system, specifically the private sector and civil society actors. According to key informants to this study, only recently have these issues come under serious consideration by the GoE.[28]

In **Mozambique**, there are similarly few effective linkages between or among agricultural research, extension, input supply services, and agricultural education in the public sector. There are even fewer linkages with private firms in agroindustry or the NGO sector. A contributing factor to these weak interactions is the inward-looking nature of many government organizations, exacerbated by internal preoccupations created by continuous reform, restructuring, and reshuffling. A prime example is the recent separation of the former Ministry of Science, Technology, and Higher Education into separate ministries for education and culture and for science and technology that effectively undermine any linkages between the two areas. Other factors include the relatively recent arrival of public extension

[28] See Spielman et al. (2006) and Gebremedhin, Hoekstra, and Tegegne (2006) for additional discussions of these issues.

services in Mozambique, and the low level of private activity in agriculture, particularly with respect to smallholders.

There have been several attempts to link research and extension in Mozambique, but they have been plagued with difficulties—not surprising given the many changes within the research system and the relative newness of the extension system. The main linkage mechanisms used include periodic revisions of technologies, multidisciplinary missions, thematic working groups, joint annual meetings, and on-farm trials (Gêmo 2006). However, some have been discontinued or staff have been reshuffled, making working together difficult. Furthermore, there are no performance indicators for some of these mechanisms.

Weak linkages are related to structural/organizational problems (lack of technical people), motivation/incentive problems (professional merit focusing on publications rather than technology transfer), lack of resources (time constraints), and communication problems (lack of equipment). The most successful research–extension linkages have occurred within the public sector in the promotion of cassava and orange-fleshed sweet potato, and in the vaccination of poultry against Newcastle disease.

Key informants to this study suggest that most AET organizations suffer from a work culture that does not promote intensive networking as part of common practice. The problem is reflected in various ways: in the traditional approach to conceptual and theoretical instruction that does not promote exposure to other actors, ideas, or processes within the agricultural innovation system, and in the weak Internet infrastructure found throughout most AET organizations, characterized by poor hardware and software, insufficient resource allocations for maintenance, user restrictions for students, and an absence of consistent institutional access to online services.

But several ongoing experiments suggest the emergence of new mechanisms and cultures aimed at facilitating greater network formation in AET. For example, the MoEC intends to create an academic credit system that will encourage students to transfer between universities and colleges (and to carry their credits with them), thereby bringing curricula toward a common level and possibly allowing students to link learning and research activities between faculty at more than one AET organization. Similarly, faculty are being encouraged to explore joint appointments, secondments, and deputizations between AET organizations as a means of meeting human-resource constraints while also building academic networks between individuals and organizations; joint task forces and committees across AET organizations are not uncommon. Students, in the meantime, are finding new opportunities for practical apprenticeships in the private and NGO sectors. And in the agricultural research community, competitive grant schemes are emerging with the potential to increase linkages with the private sector and NGOs. However, most of these networking modalities revolve around linkages among similar organizations and individuals, and do little to exploit the synergies created within nontraditional linkages.

Other areas with potential include the growth of international linkages in agriculture. For example, the absence of a Ph.D.-granting institution in Mozambique requires AET instructors to pursue their doctorates at foreign universities, typically in South Africa, Europe, or the United States. Provided that such candidates do not succumb to lucrative opportunities offered outside Mozambique, they often return with valuable research linkages, resources, and projects with foreign research universities.[29]

However, key informants to this study suggest that Mozambican faculty and organizations engaged in international research projects are often "junior" partners in largely extractive or exploitative research projects. They cite several reasons for the unbalanced relationship: the relatively limited research capacity of Mozambican researchers, insufficient incentives for Mozambican researchers to invest time or effort on research projects that do not pay salaries or consulting fees, inadequate facilities to conduct the required research, and, importantly, project designs that do not invest in building Mozambique's capacity and instead encourage the outward transfer of knowledge.

Regional linkages with neighboring South Africa and Zimbabwe offer possibilities for international linkages, as do linguistic and/or historical ties to Portugal and Brazil. To be sure, these ties are growing through commercial and academic relationships (such as with neighboring South Africa) and research relationships (potentially through the Brazilian Agricultural Research Corporation) with implications for agriculture and AET.

Of further note is the recent experiment of bringing white farmers from Zimbabwe. This small group of modern farmers was expected to contribute to agricultural production in Mozambique by bringing new agricultural technologies and practices to the largely smallholder agricultural sector. The venture has, by all accounts from key informants to this study, met with limited success due to varying factors including the quality of land granted to them, infrastructural constraints, and weak market systems in the country.

Although some efforts to link formal AET with innovative farming operations are emerging—the polytechnics are looking to establish linkages with Mozambique Leaf Tobacco and its contract-farming operations among smallholder tobacco growers, for example—few other linkages between the traditional concessionary monopolies and AET exist.

[29] Interestingly, Mozambique's integration and harmonization with other Southern African Development Community (SADC) countries raises issues for its AET curriculum and qualifications: its licenciatura degree is perceived as being less than an M.Sc. in neighboring countries, putting Mozambican AET graduates at a potential disadvantage as their network-based interactions and regional employment opportunities expand.

5. RECOMMENDATIONS FOR STRENGTHENING AET IN ETHIOPIA AND MOZAMBIQUE

As the findings of this study suggest, there are signs that AET systems in both Ethiopia and Mozambique are undergoing some degree of reform in response to changing scenarios in agricultural policies and markets. However, very few of these reforms seem to capture the key principles of the innovation systems perspective discussed above. Few reforms focus on strengthening individual and collective capabilities to innovate; changing organizational cultures, behaviors, and incentives; or building innovation networks and linkages. Few seem to prioritize the creation of a more dynamic and responsive AET system through the introduction of new and different educational approaches, learning philosophies, and shared beliefs and practices—and through opportunities to build networks that link a wider range of stakeholders in the agricultural innovation system.

Thus, it remains unclear whether these initiatives are the beginning of a substantial transformation of AET systems in Ethiopia and Mozambique or are just isolated experiments. The final outcome will depend on whether private sector investment in agriculture expands, whether budgetary and donor resources are available for improving AET, and whether new reforms focus on strengthening AET as part of a wider system of innovation in the agricultural sector. Ultimately, sustainable changes will be driven by new demands emanating from the smallholder sector, high-value crop production systems, domestic agroindustries, and other parts of the agricultural sector, and by new cultures, practices, and incentives introduced and accepted within AET organizations and among AET professionals.

Recommendations in support of these system-level changes are offered here for consideration by AET policymakers, managers, professionals, and clients. These recommendations should be viewed only as possible options and alternatives based on the findings of this study and on wider global practice in AET. Furthermore, these recommendations should only be considered in the context of country-specific priorities and capabilities.

1. Realign visions and mandates

An immediate step toward improving AET systems in Sub-Saharan Africa might be to realign the visions and mandates of AET organizations with national development aspirations by promoting new types of educational programs that are less encyclopedic and are instead more strategically attuned to the different needs of social and productive actors. In countries with extreme resource poverty and weak research capabilities such as Ethiopia and Mozambique, the comparative institutional advantages of the AET system may be strategically maximized by rethinking visions and mandates—and the functions and roles that follow from them—relative to the country's development objectives. The goal here is to move the AET system into closer, more productive relationships with other actors within the innovation system,

thereby building on the comparative advantages of different actors and institutions to achieve economies of scale and scope, reduce transaction costs, exploit complementarities, and realize synergies in the process of innovation.

2. Develop the human capital base by enhancing innovative capabilities

In the medium term, efforts to improve AET in Sub-Saharan Africa might emphasize interventions designed to further develop the innovative capabilities of the region's human capital base. Such efforts would focus on the provision of learning opportunities geared to the specific needs of different actors in the innovation system, rather than on traditional benchmarks set by standards of public service or academia. This would entail linking AET training and research agendas more closely to the needs of different user communities (such as smallholder farmers, rural traders, agroprocessors, and consumers), fostering stronger linkages between formal AET organizations and national extension systems (in all their plurality—public, private, and NGO), exploring new ways of leveraging expertise and resources from international research organizations and foreign universities, and working to meet the needs of private industry.

Specific policies and programs would focus not only on improving formal AET organizations, but also on expanding technical and vocational training institutes, in-service and on-the-job programs, distance education, and other modalities specifically adapted to the needs of diverse actors in the innovation system. Policies and programs would also focus on private sector sources of AET as a necessary complement to the formal, public sector AET system. Although it may be difficult to identify medium- and long-term market demand for AET professionals, experiences from Latin America and Asia could inform the choice of policies and programs.

3. Facilitate the flow of information and technology

Emphasis in the medium term might be placed on the development of individual and collective capabilities to access, imitate, and adapt existing information and technology by setting up the innovation networks needed to introduce this information and technology into socially or economically relevant use. Innovation networks would be designed not only to provide technical information, but to also facilitate the flow of other types of information (such as commercial or managerial) among different actors, including AET instructors, researchers, extension agents, input suppliers, output buyers, distributors, retailers, and exporters. The relatively weak or nascent involvement of foreign sources of knowledge and information evidenced above suggests that such efforts need to be complemented by renewed efforts to engage international agricultural research centers, foreign universities, and foreign entrepreneurs more aggressively in these networks.

4. Induce change in organizational cultures, behaviors, and practices

Efforts to induce change in organizational cultures, behaviors, and practices are a longer-term undertaking. Such efforts require recognition by policymakers, public administrators, AET professionals, and many other actors that formal AET organizations are not the only ones conducting research and training within an agricultural innovation system, and that linkages with a wide array of other stakeholders can effectively serve both AET organizations and the country's innovation system. Policies and programs would encourage greater openness in AET organizations to collaborating with informal AET service providers, private firms, civil society organizations, and traditional/indigenous knowledge institutions also conduct problem-solving, demand-driven research and training. Policies and programs would also focus on strengthening individual and organizational incentives to develop and retain capacity on a national scale, and on introducing organizational and managerial innovations into the AET system itself.

5. Create an appropriate policy environment

The long-term transformation of AET systems in Sub-Saharan Africa also requires an appropriate policy environment and policymakers with the knowledge and will to facilitate the transition process. Creating the right policy environment would require, among other things, developing courses on research and technology management and facilitating policy dialogues among different actors in the innovation system that put policymakers into direct contact with researchers, research managers, private firms, and civil society. AET organizations can constructively contribute to the process by serving as a convening force, providing information and analysis of policy options, and participating actively in repeated discourse.

6. Nurture high-quality human capital

A more controversial alternative for the long term is to eschew efforts to reform entire organizations and concentrate instead on those professionals with the demonstrated potential to change and effect change. Even in the most path-dependent and conservative AET organizations it is possible to identify high-quality instructors, researchers, and research teams. Although these individuals and teams rarely have the influence or power to change organizational cultures and culture and incentive structures, they can be nurtured to eventually develop a critical mass that can then force a larger process of change from within. One way to do this would be to introduce more flexible employment conditions, thereby allowing AET organizations to select those individuals with greater promise and potential, and allowing AET professionals to select organizations that allow them to realize their own potential, inducing greater mobility between and among organizations. Given the uneven distribution of innovative capabilities among individuals and organizations alike, this mobility would allow for more efficient allocation of AET

resources according to comparative advantage (such as research, teaching, extension, or private enterprise).

7. Monitor and evaluate the AET system

Continuous evaluation of AET organizations and the AET system as whole is also necessary. Teams of domestic and international experts in AET can play a critical role in assessing progress and designing roadmaps for change. These evaluations can play a critical role in helping organizations redefine their mandates and goals relative to changes in the country's AET system, the wider agricultural innovation system, and the availability of resources. Ideally, such evaluations would assist in the efficient reallocation of AET resources across teaching, research, extension, and private enterprise, based on the assumption that a strong AET system should be diversified across all four areas.

8. Adopt a long-term outlook

Changes in the practices and cultures of both formal and nonformal AET do not happen overnight; the internalization of new skills in applied problem solving, critical thinking, and entrepreneurialism can take more than a generation to become common practice in AET. Thus, shifts in policy and strategy do not effect change within five-year time spans. Individual and organizational responses to changes in structures, incentives, and financing require more time to become accepted into procedure and performance.

6. CONCLUSION

In examining the role of AET systems in Ethiopia and Mozambique, this paper relies significantly on an innovation systems perspective to make its case. Yet the innovation systems perspective is a relatively new application to the study of developing-country agriculture, and, thus, the body of methodological and empirical work that precedes this paper is still quite small. Moreover, efforts to link empirical analyses of innovation systems in developing-country agriculture and targeted recommendations that can inform public policymakers are still under development.

This paper attempts to address these issues. However, continued analysis of AET from an innovation systems perspective is needed. Specifically, more discussion is needed of how to produce extension agents, researchers, educators, and skilled laborers in sufficient quantity to boost agricultural productivity and output, *and* in sufficient quality to play an active role in a changing agricultural scenario. This implies the need for closer consideration of the more nuanced challenges of strengthening innovative capabilities among both individuals and organizations; creating organizational cultures in AET that are sufficiently open and dynamic to facilitate change; and building innovation networks, partnerships, and linkages to foster greater adaptation, imitation, and use of available information and knowledge. And ultimately, recognition is needed of the fact that interventions designed to strengthen AET systems are a long-term undertaking—only through a long-term outlook on change can AET systems contribute to the development of more dynamic and competitive agricultural economies that engage farmers, entrepreneurs, extension agents, researchers, and many other actors in a wider system of innovation.

APPENDIX A: KEY INFORMANTS

Table A.1. Key informants by organization

Organization (College/Faculty/Department)	Interviewees (no.)	
	Professionals	**Students**
Ethiopia		
Haramaya University (various)	6	13
Jimma University (Ambo College of Agriculture)	4	13
Combolcha ATVET College[a]	1	17
Holetta ATVET College	1	
Ministry of Agriculture (ATVET Department)	1	
Oromia Bureau of Agriculture (ATVET Department)	1	
Oda Flowers Company	1	
Menschen für Menschen Foundation (Agro-Technical Training College)	1	
International Livestock Research Institute (ILRI)	1	
Ethiopian Horticulture Association	1	
Mozambique		
Ministry of Education (various)	2	
Ministry of Agriculture (Directorate of Extension)	2	
Eduardo Mondlane University (various)	9	14
Boane Agrarian Institute	1	4
Higher Institute of Sciences and Technology of Mozambique (ISCTEM)	1	
Michigan State University	1	
United States Agency for International Development (USAID)	2	
Link NGO Forum	1	
World Vision International	1	
Mozambique Institute of Agricultural Research (IIAM)	4	
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)	1	
Total	**43**	**61**

[a] ATVET denotes Agricultural Technical and Vocational Education and Training.

APPENDIX B: TOPIC GUIDE FOR SEMI-STRUCTURED INTERVIEWS

Professionals[30]

We are working with the International Food Policy Research Institute and are conducting a study on agricultural education and training in your country. We would like to take about one half hour of your time, if you agree, and talk to you about agricultural education and training in your country. The information you give us will be used in the study but we will ensure the confidentiality of your response. We will share the results with you.

Background

Name of the interviewee: _____

Position in the organization: _____

Name/type of organization: _____

Date & interviewers: _____

Introduction

1. What is your organization's mandate?
___ Teaching
___ Teaching and research
___ Other: _____

2a. Has your organization's mandate, structure, or priorities changed in the past 5 years? (Yes / No)

2b. If so, how did these changes occur, or who initiated or decided on these changes?

Teaching and curriculum

3. What teaching methods and practices do you use?
___ Lecture
___ Visiting lecturers
___ Field trips and other hands-on activities
___ Group discussions
___ Technical or laboratory work
___ Other: _____

4. What teaching materials and aids do you use? (Check all that apply)
___ Textbooks and handouts
___ Laboratory equipment
___ Field equipment
___ World Wide Web and Internet
___ Overhead or LCD projector
___ Videos or DVDs
___ Other: _____

[30] Similar topic guides were used for interviews with AET learners/students, private sector actors/entrepreneurs, and AET policymakers. These guides were slightly adapted for relevance to the particular sample group, and to reflect slightly different areas of emphasis where appropriate.

5. Has the availability and use of these materials and aids improved over the past 5 years? Rate on the following scale:
Greatly decreased _____ _____ _____ _____ _____ Greatly increased

6. How would you rate your teaching methods and practices along the following scale:
Highly theoretical _____ _____ _____ _____ _____ Highly practical

7. Have there been major changes in your teaching methods in the past 5 years? (Yes / No)

8. How often has the curriculum and course content been updated in the past 5 years to incorporate new knowledge and information?
___ Every year
___ Every 2–5 years
___ Every 5–10 years
___ Never

9. If the curriculum and course content has been updated, on what topics? (Check all that apply)
___ Finance and accounting
___ Management and administration
___ Business and marketing
___ Economics and social sciences
___ Information and communications technology (ICT)
___ Community mobilization and social work
___ Other: _____

10. Are professors expected to research (as opposed to just teaching)? (Yes / No)

11. What is your time allocation between research, teaching, administration, etc.? (in percent)

12. What mechanisms are in place for evaluation of instructors in your organization?
___ Evaluation by supervisors
___ Evaluation by peers/colleagues
___ Evaluation by students
___ None

Students

13. How would you rate the quality of agricultural students in your organization?
___ Above the average of students in other similar organizations
___ About equal to students in other similar organizations
___ Below the average of students in other similar organizations

14. What do you expect to be the employment situation for your graduates?
___ They will be hired immediately
___ They will be hired after 2–6 months
___ They will not be hired for 6–12 months
___ They will not be hired for at least 12 months or more

15. Who are the main employers of graduates from your organization? Please rank.
___ Public sector
___ Private sector
___ NGOs/civil society
___ International organizations
___ Household agricultural activities (e.g., own farm)
___ Other: _____

16. In your experience, how many of your graduates actually go on to work in the agricultural sector?

___ 0–25%
___ 25–50%
___ 50–75%
___ 75–100%

17. What types of academic backgrounds are the main employers looking for? (Check all that apply)

___ Agriculture and agricultural science
___ Agricultural education
___ Finance and accounting
___ Management and administration
___ Business and marketing
___ Economics and social sciences
___ Information and communications technology (ICT)
___ Community mobilization and social work
___ Not looking for backgrounds per se
___ Other: _____

18. What type of skills are the main employers looking for? (Check all that apply)

___ Creativity (independent thinking)
___ Capacity to learn on his/her own
___ Capacity to implement plans written by the management
___ Capacity to prepare work plans
___ Capacity to search independently for information
___ Capacity to operate sophisticated equipment
___ Capacity to establish professional links with people outside the hiring organization
___ Capacity to establish links with foreign institutions
___ Other: _____

Linkages

19. In your opinion, which organizations are important sources of information and knowledge for your organization, and are your linkages with these organizations formal or informal?

	Formal	**Informal**
____ A. Public research organizations (international/regional)		
____ B. Public research organizations (federal/national)		
____ C. Public research organizations (subnational/provincial)		
____ D. Public extension services (federal/national)		
____ E. Public extension services (regional/provincial)		
____ F. Foreign technical assistance		
____ G. Public universities		
____ H. Private universities		
____ I. Vocational or technical schools		
____ J. Private firms (domestic)		
____ K. Private firms (foreign)		
____ L. Farmers' organizations/cooperatives		
____ M. Nongovernmental organizations		
____ N. International organizations		
____ O. Other (specify) _____		

20. What proportion of professional staff consults outside the organization? _____

21. Who defines the agricultural education and training teaching priorities in your organization?
___ Teaching staff
___ Research staff
___ Administrators/managers
___ Students/clients
___ Political leaders/parties
___ Ministry of Education
___ Ministry of Agriculture
___ A combination of the above (explain): _____
___ Other (explain): _____

22a. Does your organization organize courses jointly with other organizations? (Yes / No)

22b. If yes, which types of organization?
___ Private firms
___ Government organizations
___ NGOs
___ Farmer organizations
___ Other: _____

23. Does your organization facilitate internships for the students (Yes / No)? If yes, in which type of organization?
___ Private firms
___ Government organizations
___ NGOs
___ Farmer organizations
___ Other: _____

24. What other organizations within the agricultural sector does your organization interact with in the course of its activities?

25. What is the purpose of these interactions, if they exist?

Organizational incentives

26. As of January 2006, what was the average gross initial yearly salary (without benefits) of an instructor in your organization?
With a B.A.: _____
With an M.S.: _____
With a Ph.D.: _____

27. As of January 2006, what was the average value of total yearly benefits for an instructor in your organization?
With a B.A.: _____
With an M.S.: _____
With a Ph.D.: _____

28. Which are the criteria for promotion in your organization? (Check all that apply)

___ Seniority/experience
___ Upgrading of educational qualifications
___ Number of publications or technologies produced
___ Ability to fundraise
___ Ability to communicate verbally
___ Other (explain): _____

29. Which are the criteria for hiring new instructors? (Check all that apply)

___ Education attainments
___ Professional experience
____ Number of publications or technologies produced
___ Ability to conduct research
___ Ability to teach
___ Ability to fundraise
___ Ability to communicate verbally
___ Civil service transfer
___ Other (explain): _____

30. How stable are professionals in their positions?
___ Very stable (employment for life)
___ For the duration of a contract (specify duration of average contract: _____)
___ Not at all stable

31. How is job stability attained? (Check the closest period)
___ From the first day on the job
___ After a trial period of 6 months or less
___ After a trial period of 6–12 months
___ After a trial period of more than 12 months

32. What proportion of professionals in your organization is foreigners? _____

33. What proportion of professionals in your organization is female? _____

34. What proportion of professionals leaves the organization every year? _____

35. What are the most common reasons professionals give for leaving the organization? (Check all that apply)
___ Opportunities to earn higher salaries in other public research organizations
___ Opportunities to earn higher salaries in other public education organizations
___ Opportunities to earn higher salaries in nongovernmental organizations
___ Opportunities to earn higher salaries in the private sector
___ Opportunities to earn higher salaries in private educational organizations
___ Opportunities to upgrade their education level
___ Other (please explain): _____

36. What proportion of professionals has been hired in the last 5 years? _____

37. What proportion of professionals would have fulfilled the requisites for retirement in 5 years? _____

38. What support do professionals from your organization get to participate in *national* and *international professional* meetings? (Check all that apply)

	National meetings	*International meetings*
____ Payment of air/ground transport		
____ Tuition/fees/registration		
____ Per diem		
____ Paid leave		
____ Unpaid leave		
____ None		
____ Other: _____		

39. What support do professionals from your organization get to continue their formal postgraduate education in the country and abroad? (Check all that apply)

	In-country education	*Foreign education*
____ Payment of air/ground transport		
____ Tuition/fees/registration		
____ Per diem		
____ Paid leave		
____ Unpaid leave		
____ None		
____ Other: _____		

40. What support do professionals from your organization get for other opportunities: nondegree postgraduate education (e.g., short courses)**[and sabbaticals?]**? (Check all that apply)

	Nondegree postgraduate education (e.g., short courses)	*Sabbaticals*
____ Payment of air/ground transport		
____ Tuition/fees/registration		
____ Per diem		
____ Paid leave		
____ Unpaid leave		
____ None		
____ Other: _____		

41. In the last 5 years, what proportion of professionals (on average) has been engaged in the following each year?
____ Education or training (one year or more)
____ Education or training (less than one year)
____ Sabbatical

42. Which criteria are used to decide who will receive support for postgraduate training? (Check all that apply)
____ Seniority
____ Demonstrated research performance
____ Demonstrated teaching performance
____ Professional record (even though it may not include research experience)
____ Research area
____ Quotas or other allocations
____ Other (explain): _____

Infrastructure

43. What is the current condition of the teaching equipment/materials/facilities (e.g., overhead projector, classroom desks, black or white boards, etc.)?
____ Excellent
____ Good
____ Average
____ Poor
____ Nonexistent

44. What is the current condition of the library?
____ Excellent
____ Good
____ Average
____ Poor
____ Nonexistent

45. What is the condition of the information and communications technology equipment (e.g., phone, fax, computers, Internet connection, e-mail, etc.)?

____ Excellent
____ Good
____ Average
____ Poor
____ Nonexistent

46. Do you have access to the Internet and e-mail whenever you want? (Yes / No)

Evaluation and financing

47. Which are the most important mechanisms available for financing your organization? (Check all that apply)

___ Direct financing from the central government
___ Direct financing from state or provincial governments
___ Taxes/levies on specific agricultural products
___ Competitive funds
___ Contributions from the private sector
___ Contracts with the private sector
___ International assistance or donor funding
___ Other (explain): _____

48. Are the administrative procedures for managing teaching funds (either internal or external) flexible? (Yes / No)

49. Has your organization been recently evaluated? (Yes / No) If so, by whom?

50. If so, what was the purpose of the evaluation?

___ Allocate funds
___ Define priorities
___ Improve efficiency and performance
___ Decide whether organizations or programs should be phased out

51. Are these evaluations considered in the priority-setting process? (Yes / No)

Agricultural education and training characteristics

52. In your opinion, where are the weaknesses in the agricultural education and training system in your country?

___ Lack of relevancy to real needs
___ Weak curricula/content
___ Lack of skilled educators
___ Insufficient financial support
___ Weak ability to impart theoretical base
___ Weak ability to impart practical knowledge
___ Other: _____

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